INSTREAM CONTAMINANT STUDY - TASK 3

SEDIMENT TRANSPORT

Office of Natural Resources
and Economic Development
Tennessee Valley Authority

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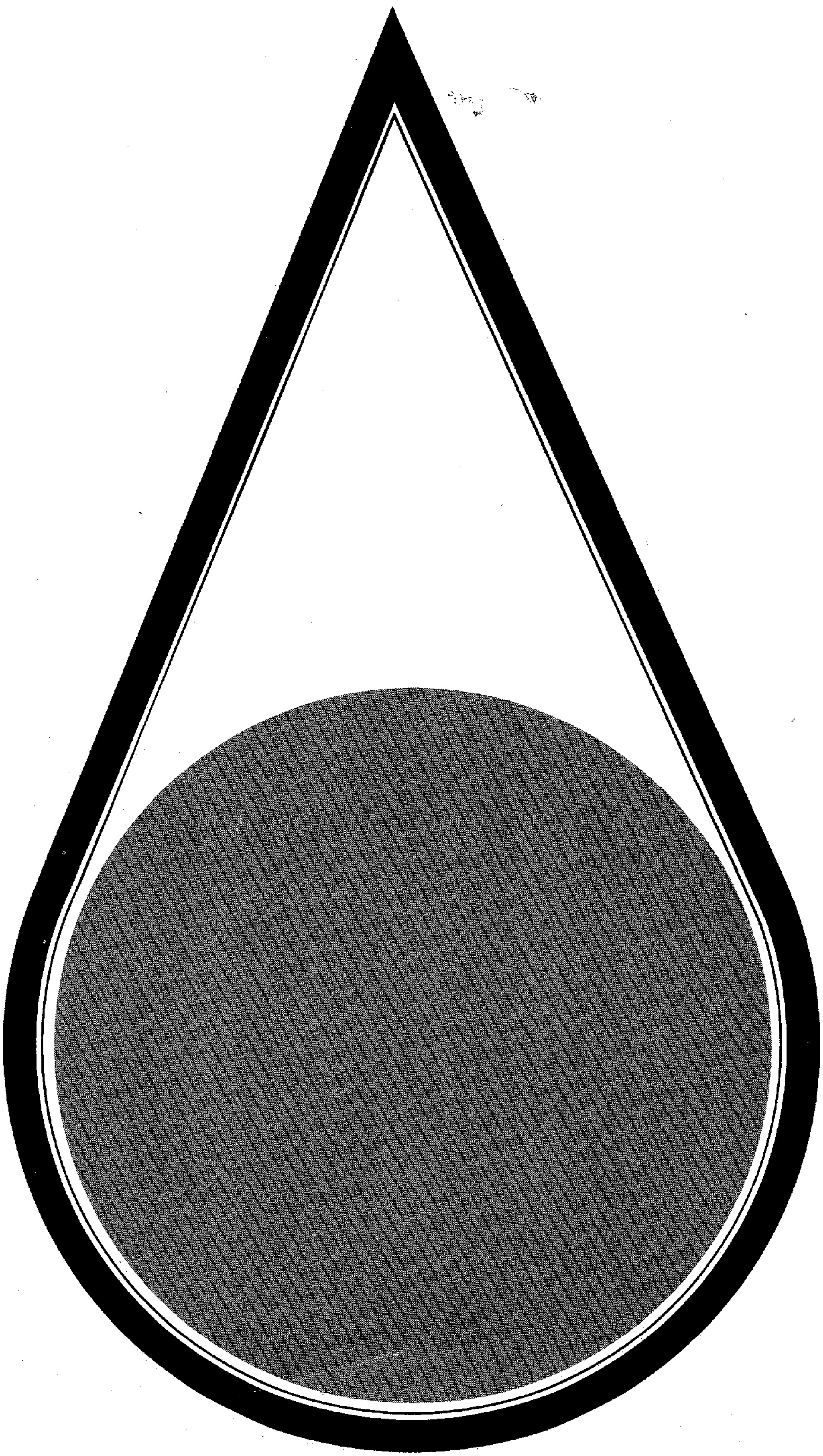
USGS



SEDIMENT TRANSPORT

TASK 3

INSTREAM CONTAMINANT STUDY

Prepared for

U.S. Department of Energy
Oak Ridge, Tennessee
Under Interagency Agreement No. DE-AI05-84OR21444

Office of Natural Resources and Economic Development
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SEDIMENT TRANSPORT
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1.0 INTRODUCTION

On November 3, 1983, the Oak Ridge Task Force under direction of the Tennessee Division of Water Management, approved conceptual workplans prepared by four subgroups of the Task Force. These workplans addressed potential offsite contamination problems associated with the Department of Energy (DOE) facilities near Oak Ridge, Tennessee. The conceptual workplans were transmitted to DOE on November 14, 1983. DOE subsequently authorized the Tennessee Valley Authority (TVA) to prepare a technical workplan covering the instream water, sediment, fish, and floodplain sampling approved by the Task Force (1). The Instream Contaminant Study workplan was submitted to DOE in February of 1984 and the work authorized by Interagency Agreement No. DE-AI05-84OR21444, TVA Contract No. TV-64095A, between DOE and TVA, and approved by the TVA Board of Directors on April 30, 1984.

This is the third of five task reports on the Instream Contaminant Study. The report addresses the potential for mercury contaminated sediment to be transported from East Fork Poplar Creek. It examines annual sediment and mercury loadings from East Fork Poplar Creek; the dynamics of mercury transport during a sampled storm; and the susceptibility of sediment to scour at cross-sections where mercury concentrations were measured in the channel and floodplains. In addition, the report presents results of a third storm event which was sampled too late in the study to be included in the Task 1 Report (Water Sampling and Analysis).

1.1 PURPOSE

The purpose of Task 3 of the Instream Contaminant Study is to assess the natural transport and/or stability of mercury contaminated sediment in the East Fork Poplar Creek and Bear Creek watersheds. The intended end result of this task is an estimate of the annual net export of mercury contaminated sediment.

1.2 EAST FORK POPLAR CREEK WATERSHED

1.2.1 WATERSHED DESCRIPTION

East Fork Poplar Creek drains an area of 29.8 square miles that is approximately rectangular in shape, and some 9 miles long by 3-1/2 miles wide. There is one major tributary, Bear Creek, which has a total drainage area of 7.39 square miles and drains into East Fork Poplar Creek at mile 1.47.

East Fork Poplar Creek has its origins at the Y-12 plant south of Oak Ridge. The area of interest in this study extends from East Fork Poplar Creek mile ~~13~~14.36 (located about 0.3 mile below New Hope Pond) to a station influenced by the backwaters of Watts Bar Reservoir, EFPCM 0.03. The northwest boundary of the watershed is Black Oak Ridge which rises to elevations of over 1,200 feet and divides the East Fork Poplar Creek valley from the main portion of Poplar Creek. Bear Creek watershed parallels East Fork Poplar Creek watershed for much of its length and is separated from it by East Fork Ridge which rises to elevations of over 1,100 feet. The southeast divide is Chestnut Ridge which separates Bear Creek watershed from that of White Oak Creek. The average slope of East Fork Poplar Creek from the upstream limits of the reservoir backwater to the upper end of the study area is approximately 9.2 feet per mile. Drainage areas for flow measuring stations used in the study are presented in Table 1. Figure 2 in the Task 1 report shows the locations of the primary sampling stations.

TABLE 1

Drainage Areas for Measuring Stations
Instream Contaminant Study - Task 3

Stream	River Mile	Drainage Area (mi^2)	Remark
East Fork Poplar Creek	14.7	1.25	New Hope Pond
East Fork Poplar Creek	14.36	1.69	TVA Gage Site
East Fork Poplar Creek	10.0	8.72	TVA Gage Site
East Fork Poplar Creek	6.89	13.9	TVA Gage Site
East Fork Poplar Creek	3.3	19.5	USGS Gage
East Fork Poplar Creek	0.03	29.8	Lowest TVA Station
Bear Creek	0.8	7.15	Former USGS Gage
Bear Creek	0.55	7.27	TVA Gage Site
Mill Branch	0.20	1.75	TVA Gage Site

1.2.2 LAND COVER

East Fork Poplar Creek drains portions of the City of Oak Ridge and its suburbs for over half its upper length. The City of Oak Ridge had a population of 27,662 in 1980 (2). Recently an increasing number of subdivisions have developed along the Oak Ridge Turnpike which parallels East Fork Poplar Creek. For the watershed area upstream of the U.S. Geological Survey stream gage (EFPCM 3.3) the approximate land use distribution is as follows: urban - 15 percent; grass (pasture, lawn, etc.) - 28 percent; and forest - 57 percent. Bear Creek watershed is undeveloped except for the Y-12 plant at the headwaters and a road along the valley. There are numerous waste disposal facilities located in the East Fork Poplar Creek watershed, including the Oak Ridge West End Sewage Treatment Plant at approximately EFPCM 8.3 and waste burial grounds in the Bear Creek watershed.

1.2.3 GEOLOGY

The study area is in the Valley and Ridge physiographic province (3). Northeast-trending ridges at elevations of 1,000 to 1,200 feet are formed by rocks resistant to weathering such as sandstones and shales. The valleys are generally flat, lie at elevations of 750 to 850 feet, and are underlain by much less resistant rock.

The valley of East Fork Poplar Creek is underlain by the Middle Ordovician age rocks of the Chickamauga Limestone while that of Bear Creek is underlain by Middle Cambrian rocks of the Conasauga Group. Although there are a number of faults which parallel and lie between East Fork Poplar Creek and Bear Creek, only the upper and lower reaches of East Fork Poplar Creek and the lower reaches of Bear Creek intercept these faults where they drain through gaps in the ridges (4).

1.2.4 FLOW AUGMENTATION

East Fork Poplar Creek originates at the DOE Y-12 plant where New Hope Pond is, in effect, the head of the creek. The pond receives storm water drainage from the plant site and process water from the plant. Table 2 presents average daily flow data from New Hope Pond by month for a 5-year period (1980-1984), as measured by Y-12 plant personnel (5). The drainage area of the creek upstream of New Hope Pond, based upon pre-Y-12 plant topography, is 1.25 square miles.

The sewage treatment plant for the City of Oak Ridge (outfall at EFPCM 8.3) also augments flow in the creek. Table 3 shows the average daily discharge data obtained from plant records by month for 1983 and 1984.

NHP & STP

The data in Tables 2 and 3 indicate that an average daily flow of approximately 21.5 cfs are added to East Fork Poplar Creek from these two sources. Some of the flow from the drainage area above New Hope Pond would have occurred if the Y-12 plant had not been constructed. Based on an average annual observed runoff of about 23 inches for two

13.5 + 8.0
NHP STP

58.4 cm

TABLE 2

Average Daily Flows at New Hope Pond
Instream Contaminant Study - Task 3
(values in cubic feet per second)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Avg.
1980	14.4	10.8	20.0	12.8	12.5	13.5	11.3	11.4	12.2	13.9	13.6	11.6	13.2
1981	10.7	12.9	11.2	12.7	10.5	12.2	11.3	9.9	10.9	10.1	10.2	10.4	11.1
1982	13.9	NR	15.0	12.6	11.9	12.7	13.8	14.3	14.2	12.8	15.8	16.3	13.9*
1983	12.7	15.7	13.7	15.5	14.9	12.6	13.4	12.5	12.2	13.4	14.5	15.5	13.9
1984	16.0	16.4	14.3	20.6**	18.1	13.8	15.7**	13.1**	12.5**	16.6**	14.7**	11.6**	15.3**
											Average		13.5 CFS ≈ 8.8 MGD

NR = Lost Record
*Excludes February
**Incomplete Record
Data obtained from Martin Marietta Energy Systems

TABLE 3

Average Daily Flows at Sewage Treatment Plant
Instream Contaminant Study - Task 3
(values in cubic feet per second)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Avg.
1983	5.0	7.9	6.5	8.8	8.6	6.9	6.6	NR	6.1	6.4	7.7	10.7	7.4*
1984	8.5	8.9**	9.0	9.0	10.2	7.6	9.6	7.0	6.9	7.9	8.8	8.3	8.5
1985	8.2	9.7	7.8	8.1	8.1								8.4
											Average		8.0

3-10 cfs in 1961-64 (McMaster 1967)

NR = lost record
* For 11 months
**5 days missing

What is the area of these watersheds relative to EFPC? (Area of EFPC = 29.8 mi.^{2})

short-term USGS stream gages in the vicinity (Melton Hill Branch near Oak Ridge and Bear Creek near Oak Ridge), the average natural mean daily discharge from the drainage area upstream of New Hope Pond would have been about 2.1 cfs were the Y-12 plant not present. Thus, these two sources apparently augment the flow in East Fork Poplar Creek by about 21.5 - 2.1 = 19.4 cfs. To place this value in perspective, the average 23-year unadjusted mean daily discharge at the USGS stream gage on East Fork Poplar Creek at mile 3.3 was 51.9 cfs. If this flow were reduced by 19.4 cfs to 32.5 cfs the resulting annual runoff of 22.6 inches is very nearly that of nearby watersheds.

1.2.5 MERCURY CONCENTRATIONS - NEW HOPE POND

Table 4 presents average daily total mercury concentrations by month at the New Hope Pond outfall for the period January 1984 through May 1985. Because the record is incomplete the number of days sampled are noted. Based upon an average flow of 15.3 cfs for 1984 (see Table 2) and the average concentration of 2.5 mg/L shown in Table 4, the average daily mercury load from New Hope Pond for 1984 was 0.2 pounds (or 75 pounds/year). Most of this mercury is adsorbed onto solids and probably deposited in the creek where it becomes resuspended during storm events.

TABLE 4

Average Monthly Mercury Concentrations of Discharges
from New Hope Pond
Instream Contaminant Study - Task 3

Year		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg
1984	n	22	20	17	10	22	21	20	20	18	4	--	1	--
	mg/L	3.1	2.2	1.9	1.7	2.4	1.9	2.2	2.2	1.8	4.4	--	3.6	2.5
1985	n	--	4	4	5	3	--	--	--	--	--	--	--	--
	mg/L	--	2.8	2.5	1.9	1.6	--	--	--	--	--	--	--	2.2

n = number of observations.
Data obtained from Martin Marietta Energy Systems

1.3 HYDROLOGY

1.3.1 RAINFALL

There are three relatively long-term rain gages in the vicinity of the study site. At these gages, the average or normal annual rainfall and the length of record are: Melton Hill Dam - 54.11 inches (19 years); Bull Run Steam Plant - 53.84 inches (17 years); and Oak Ridge at the U.S. Weather Bureau (USWB) station - 54.76 inches (30 years). The normal monthly rainfall for the Oak Ridge USWB station, based upon the period 1951-1980, is shown in Table 5. To supplement these records, a temporary rain gage was installed adjacent to Bear Creek Road and operated from August 1984 through April 1985.

TABLE 5

Normal Monthly Rainfall - Oak Ridge
Instream Contaminant Study - Task 3
(values in inches)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
5.25	4.60	6.21	4.41	4.23	4.26	5.21	3.75	3.80	2.89	4.50	5.65

≈ 54.76 in

1.3.2 FLOOD FLOWS

The only long-term stream gage record maintained on East Fork Poplar Creek is the USGS gage No. 03538250 at mile 3.3. As part of a Flood Insurance Study for the City of Oak Ridge, the TVA Flood Protection Branch determined an annual maximum flood frequency based on records for the period 1961-1981 using procedures outlined in USGS Bulletin 17B, including the use of the generalized skew map, Plate I (6). Historic data prior to 1961 were not used in the frequency analysis because these floods occurred under different channel conditions and watershed urbanization than exist today. The estimated discharges for floods of various recurrence intervals are shown in Table 6. The discharge for the 30-year return period shown in Table 6 is equal to the largest discharge measured since 1950. (The largest known flood occurred September 29, 1944 and had a peak discharge of 4,600 cfs which has a return period of about 50 years).

TABLE 6

Flood Discharges for Various Recurrence Intervals
East Fork Poplar Creek, Mile 3.3
Instream Contaminant Study - Task 3

Recurrence Interval-Years	Peak Discharge - cfs
1.05	700
2	1500
5	2300
30	4100
200	6400
500	7800

1.3.3 STORMS SAMPLED

Three storms were sampled during the study on the following dates: October 22-23, 1984; November 10-11, 1984; and April 5-6, 1985. Data collected during the first two storms are presented in the Task 1 report and data collected during the third storm are presented in the Appendices of this report.

Rainfall measured during the three storms (at the temporary TVA gage) was as follows: October 22-23, 1984--3.35 inches (2.0 inches for the hydrograph sampled and 1.35 inches subsequently); November 10-11, 1984--1.42 inches; and April 5-6, 1985--1.10 inches. The latter two storms were fairly continuous while the first storm occurred as three separate events over the two-day period.

The streamflow and water quality data collected during the three storms are summarized in Table 7. For each storm, the peak discharge and the highest and lowest value measured for total suspended solids (TSS), total mercury (THg), and dissolved mercury (DHg) are presented.

Several observations can be made from the data presented in Table 7. First the peak discharges for the three storms are low relative to the flood frequency information presented in Section 1.3.2. The peak discharges, for example, at EFPCM 3.3 are only a small fraction of the flood discharge for a 50 percent probability flood (a 2-year recurrence interval), and less than half the base discharge (700 cfs) used by the USGS to identify extreme discharges at this station, as published in the

TABLE 7

Maximum and Minimum Values of TSS, THg, and DHg for
the Three Storm Events Sampled
Instream Contaminant Study - Task 3

highest & lowest values [illegible] &

Parameter	East Fork Poplar Creek					Bear Creek	Mill Branch
	M14.36	M10.0	M6.89	M3.3	M0.03	M0.55	M0.2
Storm #1 October 22-23, 1984							
Peak Q (cfs)	220	360	446	310	--	82	19
TSS (mg/L)	120/16	300/40	370/30	440/81	590/62	550/38	30/3
THg (mg/L)	11.0/1.4	7.0/2.9	--	11.0/1.5	--	1.1/0.4	--
DHg(mg/L)	0.3/<.2	0.7/<.2	--	0.3/<.2	--	0.7/<.2	--
Storm #2 November 10-11, 1984							
Peak Q (cfs)	88	224	316	247	--	66	14
TSS (mg/L)	570/25	600/2	300/68	350/18	550/16	130/17	72/5
THg (mg/L)	26.0/2.1	24.0/5.2	--	12.0/0.9	--	0.5/0.2	--
DHg (mg/L)	0.4/<.2	0.2/<.2	--	0.9/<.2	--	<.2/<.2	--
Storm #3 April 5-6, 1985							
Peak Q (cfs)	78	237	335	246	--	62	25
TSS (mg/L)	210/33	490/40	890/40	770/140	580/66	1000/64	47/<1
THg (mg/L)	11.0/2.5	44.0/3.4	--	16.0/3.7	19/2.3	1.6/0.2	--
DHg (mg/L)	<.2/<.2	<.2/<.2	--	<.2/<.2	<.2/<.2	<.2/<.2	--

-- Indicates data not collected.

USGS Water Resources Data Reports (7). The highest discharges recorded on East Fork Poplar Creek occurred during the first storm, yet these discharges only approached bankfull stage at the four measuring stations.

The second observation from Table 7 is that the peak discharge actually decreased between EFPCM 6.89 and EFPCM 3.3 even though there was an increase in the contributing drainage area of 5.6 square miles (Table 1). This anomalous flow condition was investigated and does not appear to be caused by streamflow measuring error. No cause for the reduced flow was apparent. It does appear to be a characteristic of the stream, however. The USGS maintained a crest marker station at Wiltshire Drive (D.A.=8.72 sq. miles) during the 1960s. For storms with moderate peak discharges (e.g., less than N1,500 cfs at the gage at EFPCM 3.3), the unit discharges (cfs per square mile) at the upstream station are much higher than those at the lower station. For higher floods the unit discharges at both stations appear to be comparable although the number of peak discharges measured at the upstream station which could be compared with a published discharge at the downstream gage was limited.

The third observation from the data in Table 7 is that the maximum sediment concentrations measured during the three storms were fairly high considering that none of the storms had high discharges. The highest concentration measured was 1,000 mg/L at Bear Creek during the third storm, while the highest measured at the other locations was on the order of half of this value.

The fourth finding evident in Table 7 is that the concentrations of the dissolved mercury are relatively low. Most of the dissolved mercury concentrations were below the detection limit or only slightly above. Consequently, most of the mercury transported during these storm events was in the suspended form.

The fifth observation from Table 7 is that there is no obvious spatial trend in the total mercury concentration among the stations, except for

Bear Creek where the concentrations are much lower. The highest total mercury concentration measured on East Fork Poplar Creek (44 mg/L) was at mile 10.0 during the third storm. However, relatively high maximum concentrations were also measured at miles 14.36 and 3.3. Similarly high concentrations were also measured during the other two storms.

2.0 APPROACH

2.1 ORIGINAL APPROACH

The original approach for predicting the potential for transporting mercury-contaminated sediments from the overbank sections of East Fork Poplar Creek was to model sediment transport in two phases (1). A watershed model was to be used to quantify the wash load from local areas and the results were to be used as input to a sediment transport model capable of handling deposition and scour. This combined modeling approach was to be validated using data collected during Task 1. The combined model could then be used to predict sediment transport during statistically generated larger storms and the expected degree of channel "cleansing" of the mercury contaminated sediments during a 10-year period could be predicted.

2.2 FINDINGS NECESSITATING A REVISED APPROACH

After evaluating the water and sediment data obtained as part of Tasks 1 and 2, the original approach was revised for the following reasons:

(1) The sediment transport model originally planned for use was designed to quantify the scour/deposition/transport of suspended sediment loads within the stream channel. When the Task 2 results showed that most of the mercury was in the floodplain sediments, detailed analysis of channel sediment transport became less significant.

(2) No storms with significant overbank flows occurred during the sampling period from August 1984 through April 1985. Consequently, it was not possible to calibrate and validate a sediment transport model for scour/deposition/transport of sediment from floodplain areas.

(3) During the study it became evident from field observations that the overbank areas are relatively stable. Large trees and dense vegetation present in most areas indicate these areas have been stable for some period of time. During flooding conditions deposition, rather than scour, is probably prevalent in most of the undisturbed overbank areas.

(4) Considering the above, a more direct approach for estimating sediment and mercury transport from East Fork Poplar Creek appeared necessary and justified.

2.3 REVISED APPROACH

The basic issues in this task are two-fold. (1) What is the annual transport of sediment and mercury from East Fork Poplar Creek? (2) What degree of cleansing (scour) of the mercury-contaminated floodplain sediments can be expected to occur from future large floods? These issues are addressed as follows.

The storm event data (streamflow and water quality) collected as part of this study are used to develop sediment and mercury rating functions. These rating functions are then applied to a streamflow duration distribution available for the USGS stream gage at EFPCM 3.3 to determine the average annual sediment and mercury loadings from East Fork Poplar Creek. The annual mercury loading from Bear Creek watershed are similarly estimated using data from a USGS gage at BCM 0.8. Mercury transport during measured storms is quantified by applying the mercury rating function to hydrographs measured during sampled storms.

The potential for future large floods to scour mercury-contaminated sediment from floodplain areas is investigated using a flow model to predict velocities in overbank sections where mercury in the deposited sediment has been measured. These predicted velocities provide insight into the potential for scouring over a range of future flood magnitudes.

3.0 DATA ANALYSIS

3.1 ANNUAL SEDIMENT AND MERCURY LOADS

3.1.1 RATIONALE FOR APPROACH

No storms occurred during the project sampling period with discharges sufficiently high to calibrate and verify a floodplain sediment transport model. Adequate data were obtained during the three storm events to establish mercury and suspended sediment rating functions (functional relationships between transport rates and streamflow). These rating functions were applied to streamflow duration data obtained at long-term gaging stations to determine a loading duration relationship. The integral of this latter relationship provides an estimate of the mean annual sediment or mercury load.

3.1.2 FLOW DURATION DATA

Two continuous stream gages have been maintained in the East Fork Poplar Creek watershed, both by the USGS. Flow duration data were obtained for the station on EFPCM 3.3 (Station number 03538250) for a 23-year period from 1961 to 1983; and a station at BCM 0.8 (Station number 03538275) for the 4-year period from 1961 to 1964. Although the record for the Bear Creek station is relatively short, it is the only continuous record of any length available on the tributary.

Table 8 presents flow duration data obtained from the USGS. Shown are the number of times the mean daily discharge fell into each flow class.

TABLE 8

Flow Duration Data for
EFPCM 3.3 and BCM 0.8
Instream Contaminant Study - Task 3

Class	Daily Discharge (cfs)	No. Days	Class	Daily Discharge (cfs)	No. Days	Class	Daily Discharge (cfs)	No. Days
East Fork Poplar Creek Mile 3.3								
0	0.0	0	12	63.0	328	24	380.0	19
1	12.0	1	13	73.0	248	25	440.0	29
2	14.0	12	14	85.0	190	26	520.0	6
3	16.0	361	15	99.0	109	27	600.0	9
4	19.0	1005	16	110.0	132	28	700.0	7
5	22.0	1133	17	130.0	86	29	810.0	7
6	25.0	1317	18	150.0	103	30	940.0	3
7	30.0	694	19	180.0	61	31	1100.0	2
8	34.0	762	20	210.0	38	32	1300.0	3
9	40.0	589	21	240.0	35	33	1500.0	2
10	46.0	595	22	280.0	26	34	1700.0	2
11	54.0	466	23	330.0	20		Total	8400
Bear Creek Mile 0.8								
0	0.0	0	12	4.1	66	24	41.0	13
1	0.5	44	13	5.0	77	25	50.0	16
2	0.61	59	14	6.1	60	26	60.0	13
3	0.73	45	15	7.3	68	27	73.0	11
4	0.89	70	16	8.9	69	28	89.0	6
5	1.1	79	17	11.0	73	29	110.0	3
6	1.3	78	18	13.0	70	30	130.0	3
7	1.6	95	19	16.0	63	31	160.0	3
8	1.9	53	20	19.0	37	32	190.0	4
9	2.3	72	21	23.0	43	33	230.0	5
10	2.8	70	22	28.0	34	34	280.0	2
11	3.4	73	23	34.0	24		Total	1461

The average discharge between classes was used in the subsequent calculations since the number of days refers to the number of times the mean daily discharges occurred between the classes.

3.1.3 RATING FUNCTIONS

The mercury and suspended sediment data collected during this study were related to the concurrent discharge measurements to establish rating functions. Two techniques were employed for measuring total suspended solids (TSS): depth integrated samplers and PS69 automatic samplers (see Task 1 report, Section 3.1.2.1). Figure 1 is a plot of paired samples from EFPCM 3.3. The figure shows that there is a bias between the two sampler measurements. Since the depth integrated sampler is generally accepted as providing the most representative measure of TSS, an adjustment was applied to the PS69 sampler to make the measurements comparable. The correction equation obtained by regression was:

$$TSS_{DI} = 1.655\ TSS_{PS69}^{0.98} \qquad r = 0.89$$

where: TSS_{DI} = depth integrated concentration - mg/L
TSS_{PS69} = PS69 measured concentration - mg/L
r = correlation coefficient

Figure 2 shows the TSS discharge rating function for EFPCM 3.3 (using adjusted PS69 data). Log transformed data from all three storms were used to develop the linear regression equation.

Rating functions were also determined for the total mercury loading (THg) versus discharge at EFPCM 3.3 and BCM 0.55. Only total mercury was considered since most of the dissolved mercury data were below the detection limit. The relationships are shown in Figures 3 and 4, respectively. Table 9 presents the rating functions and correlation coefficients for both TSS and THg at EFPCM 3.3 and for THg at BCM 0.55.

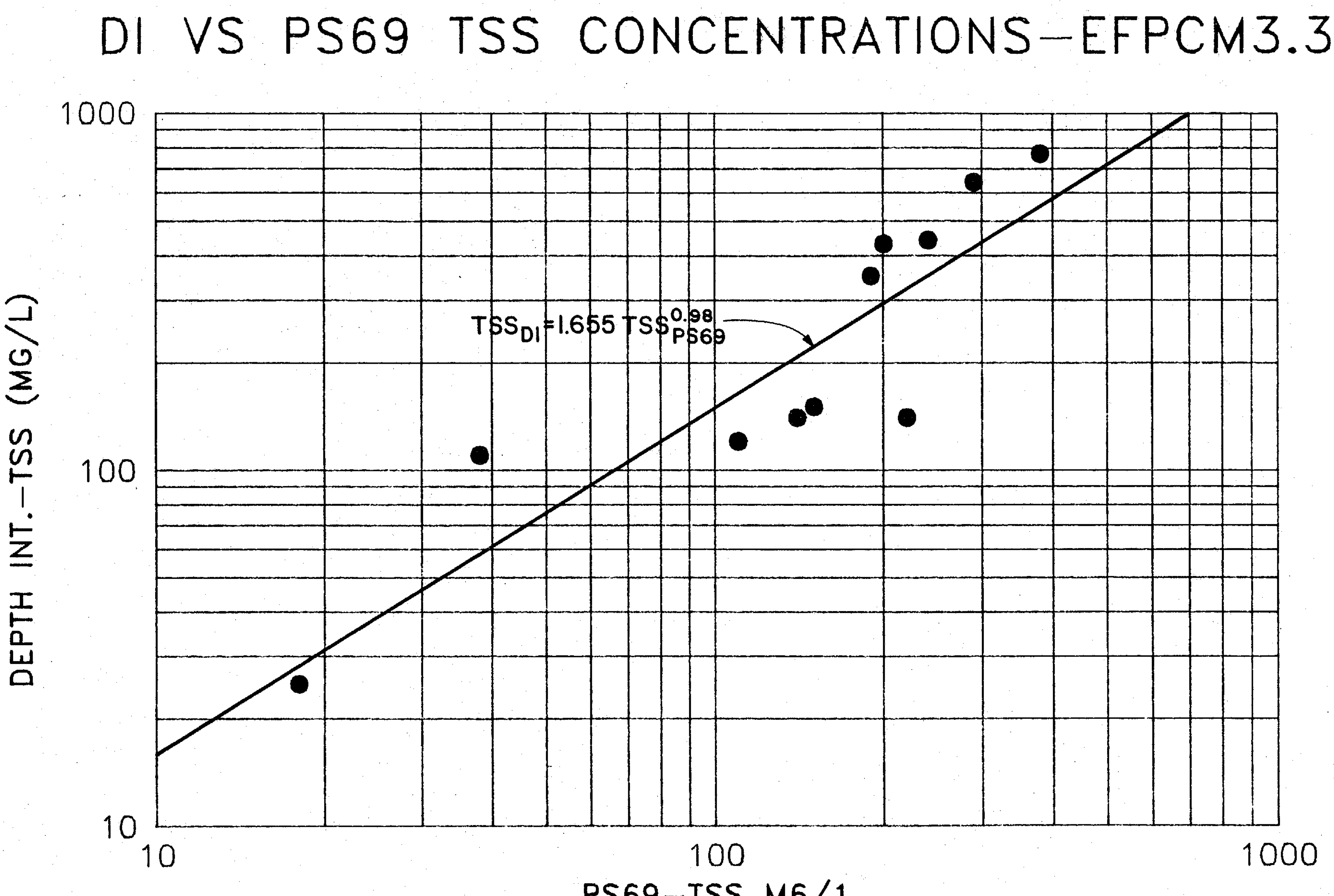

Figure 1: Total Suspended Solids, Depth Integrated vs PS69 Samplers

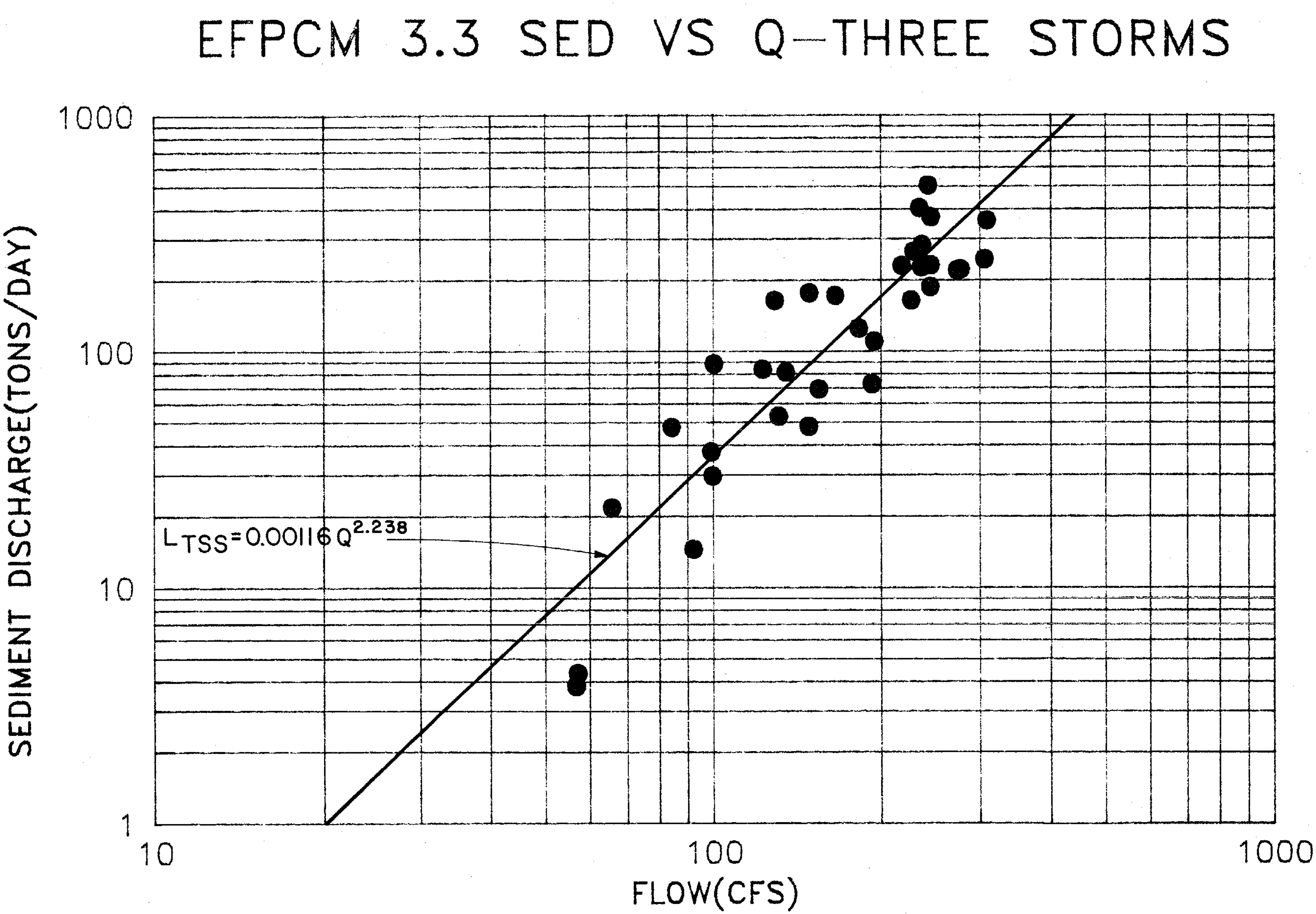

Figure 2: Total Suspended Solids vs Discharge, EFPCM 3.3

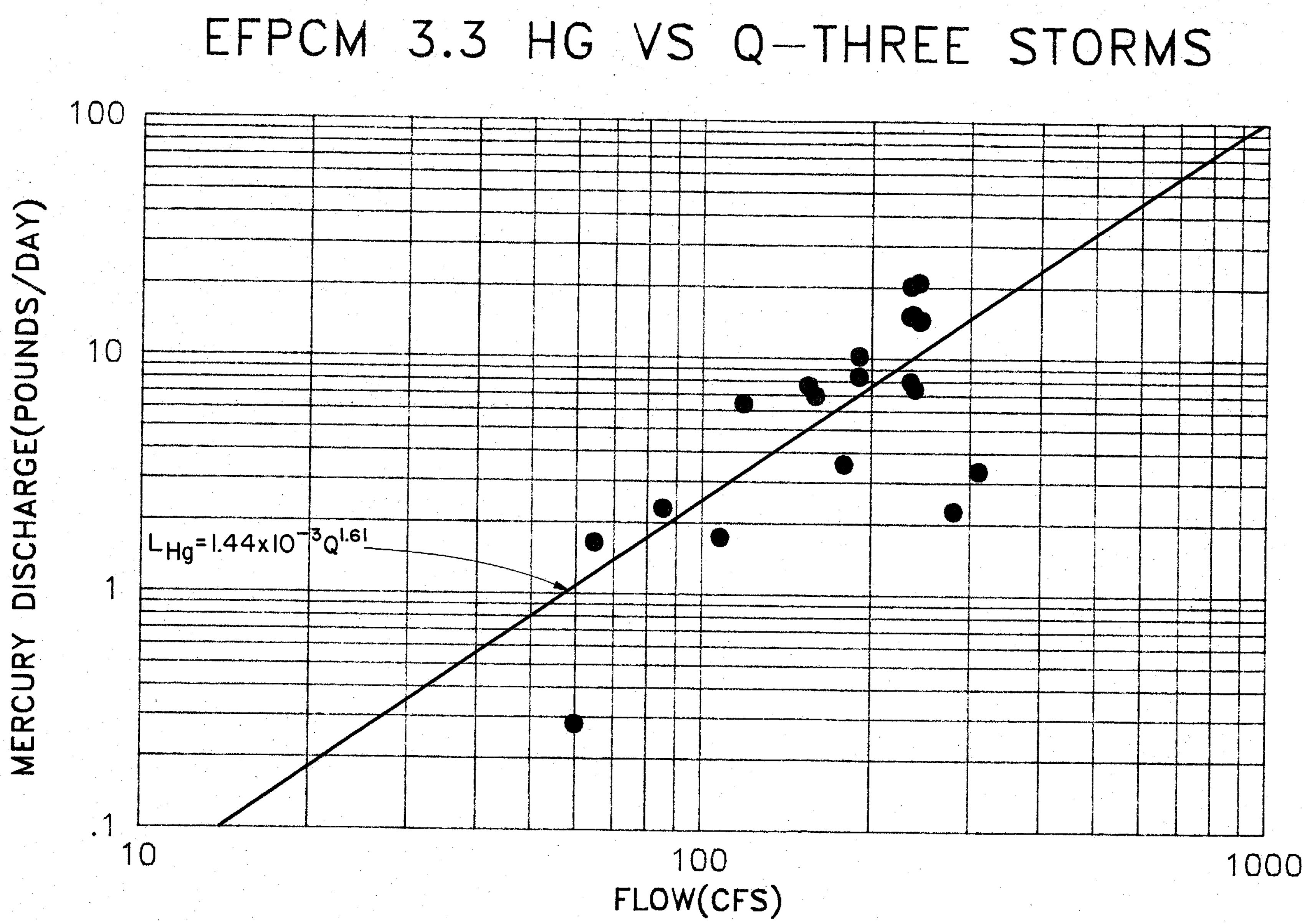

Figure 3: Total Mercury vs Discharge, EFPCM 3.3

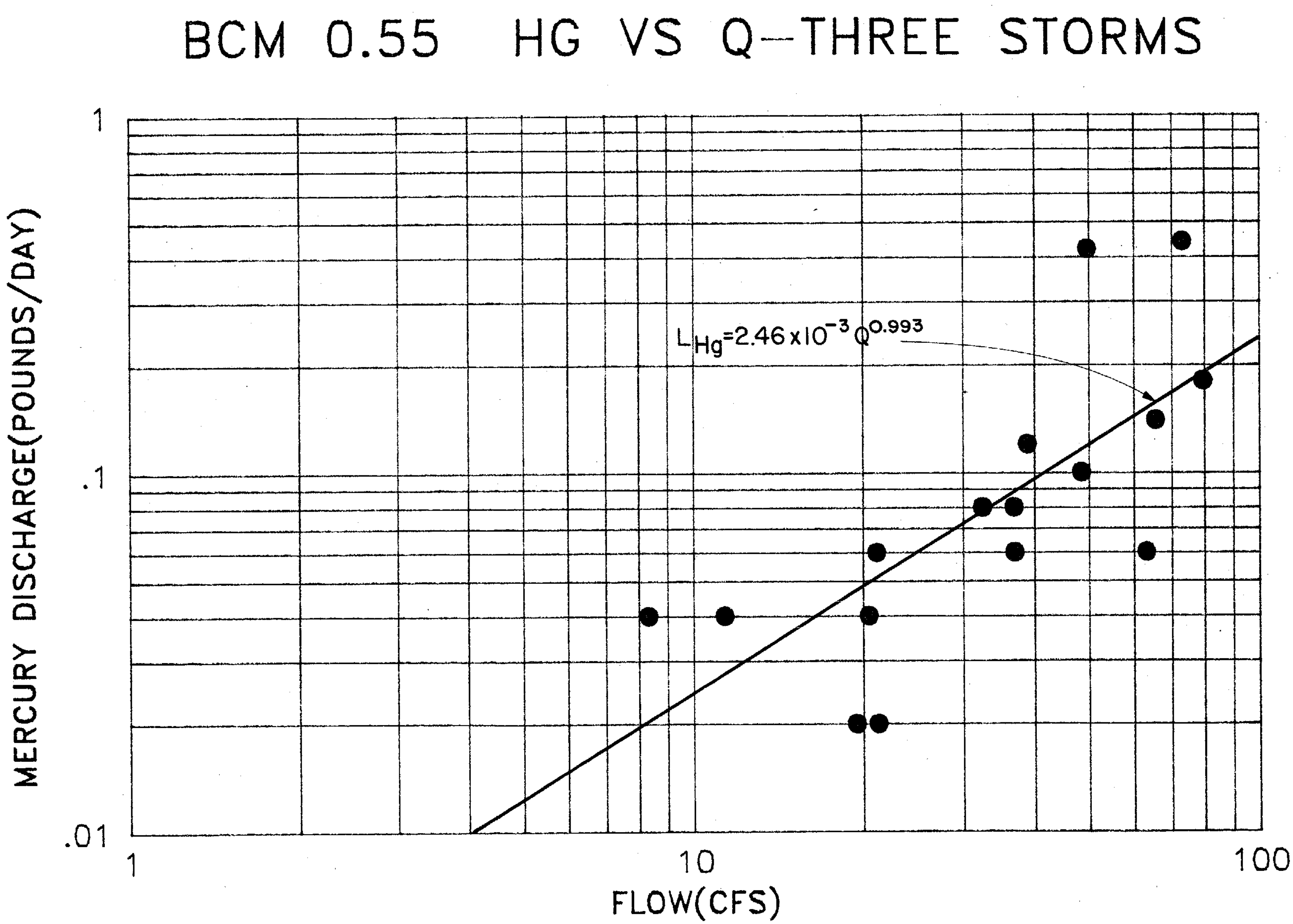

Figure 4: Total Mercury vs Discharge BCM 0.55

TABLE 9

Total Suspended Solids and Total Mercury Versus
Flow Regression Equations for
EFPCM 3.3 and BCM 0.55
Instream Contaminant Study - Task 3

East Fork Poplar Creek Mile 3.3

$L_{TSS} = 0.00116\ Q^{2.238}$ r = 0.90

$L_{THg} = 1.44 \times 10^{-3}\ Q^{1.61}$ r = 0.72

Bear Creek Mile 0.55

$L_{THg} = 2.46 \times 10^{-3}\ Q^{0.993}$ r = 0.73

where: L_{TSS} = total suspended solids load - tons/day

L_{THg} = total mercury load - pounds/day

Q = concurrent streamflow discharge - cfs

r = correlation coefficient

3.1.4 CALCULATED ANNUAL LOADS

The rating functions presented in Table 9 were applied to the appropriate flow data given in Table 8 and the resulting predicted loads multiplied by the percent of the total number of days in the class interval. The rating function for BCM 0.55 was assumed to be applicable at the stream gage site, BCM 0.8, since the difference in drainage area is only 0.12 square mile. The annual loads are presented in Table 10.

Caution must be exercised in using these calculated loads. As shown in Figures 2-4 there is substantial scatter in the data. Also, the calculated loads involve extrapolating these functions to larger and smaller discharges than were measured. Figures 2 and 3 show that the highest discharge measured in this study was about 300 cfs at EFPCM 3.3.

TABLE 10

Predicted Annual Sediment and Mercury Loads for
East Fork Poplar Creek Mile 3.3 and Bear Creek Mile 0.8
Instream Contaminant Study - Task 3

	Predicted Value
East Fork Poplar Creek Mile 3.3	
Suspended Sediment - tons/year	17,400 / 19.5 mi^2
Suspended Sediment - tons/mi^2/year	895
Total Mercury - pounds/year	504
Bear Creek Mile 0.8	
Total Mercury - pounds/year	11.1
Total East Fork Poplar Creek Watershed	
Total Mercury - pounds/year	515

Table 8 indicates that this discharge is exceeded about 1.5 percent of the time (the highest mean daily discharge during the period of record was 1,790 cfs). Similarly, the highest measured discharge at BCM 0.55, shown in Figure 4, was about 80 cfs. Table 8 indicates that this flow is exceeded about 2 percent of the time (the highest mean daily discharge during the period of record was 410 cfs). As a result, the percentage of the calculated annual loads derived from flows in excess of the measured discharges are approximately 70, 40, and 25 percent for TSS and THg at EFPCM 3.3 and THg at BCM 0.8, respectively. Similarly, the lowest discharge measured at EFPCM 3.3 was 60 cfs which exceeds flows that occurred about 77 percent of the time and during which 24 percent of the estimated annual mercury load was transported.

A second limitation of the loads presented in Table 10 is that rating functions derived from instantaneous data were applied to mean daily discharge measurements. For smaller relatively flashy streams such as these, the mean daily discharge is not always representative of the actual short-term flow condition during a day, particularly during flood events. For example, the highest instantaneous peak discharge measured during the 23-year record used to develop the flow duration data shown in Table 8 (4,100 cfs), occurred on November 28, 1973, when the mean daily discharge was 1,680 cfs. The bias obtained using mean daily discharges increases in proportion to the exponent term of the equations shown in Table 9 (i.e., when the exponent is 1.0, a direct relationship exists between transport and discharge, and the results are the same using either instantaneous or mean daily discharges).

3.1.5 COMPARISON OF RESULTS

The predicted annual sediment load for EFPCM 3.3, shown in Table 10, is 895 tons per square mile. As in the case of sediment concentrations, this sediment load appears to be high in comparison to values measured at other watersheds in the Tennessee Valley (see Reference 8, page 46). The sediment loads measured at other watersheds in the Valley were obtained from relatively short-term records from mostly rural watersheds. Guy and Jones (9) conducted a study of urban sedimentation and presented relationships between sediment discharge and drainage area using data collected primarily from the Baltimore and Washington, D.C., metropolitan areas. Their relationships indicate sediment discharges ranging from 250 to 600 tons/square mile for a 19.5 square mile watershed (such as EFPC above mile 3.3) under rural conditions. However, when a small part of the basin is affected by urbanization, they project sediment discharges ranging from 1,000 to 3,000 tons/square mile. Although these figures are not necessarily transposable to east Tennessee, the data clearly show that urbanization and channel realignments such as occurred in EFPC watershed can dramatically increase the sediment discharge in a watershed. Thus, the sediment loads measured in the East Fork Poplar Creek watershed may reflect the impact of urbanization in Oak Ridge.

The predicted annual load of 515 pounds of mercury from East Fork Poplar Creek Watershed is almost seven times that currently being released annually from New Hope Pond (see Section 1.2.5). (No information on mercury contributions from the Oak Ridge sewage treatment plant are available). Thus, it appears that a substantial portion of the annual load of mercury is being derived from mercury-contaminated sediment in the channel or floodplains. This estimated annual load is small, however, relative to the estimated 160,000 pounds of mercury contained in the sediments of East Fork Poplar Creek and its floodplain. (See Task 2 report, Table 11).

The source of the relatively small load of mercury discharged annually from Bear Creek is unknown. The sediment sampling conducted as part of this study found mercury concentrations in the Bear Creek watershed near background levels. (See Task 2 report, Section 4.2.1.2).

3.2 MERCURY TRANSPORT DURING SAMPLED STORMS

The transport of mercury in East Fork Poplar Creek during the sampled storms provides insight into existing conditions (at least for within-bankfull flows), and allows a comparison with the average annual mercury loads presented in the previous section. As was done in the previous section, only total mercury concentrations were considered since most of the dissolved mercury concentrations were below the minimum detection limit.

3.2.1 MERCURY RATING FUNCTIONS

Figures 5 and 6 show the relationship between total mercury transport and the concurrent discharge for data measured during the three storm events at East Fork Poplar Creek stations at mile 14.36 and mile 10.0, respectively. As was done for the relationships for EFPCM 3.3 and Bear Creek presented in Table 9, the data for the three storms were combined. The rating functions are shown on the figures. Table 11 presents the regression equations and the correlation coefficient.

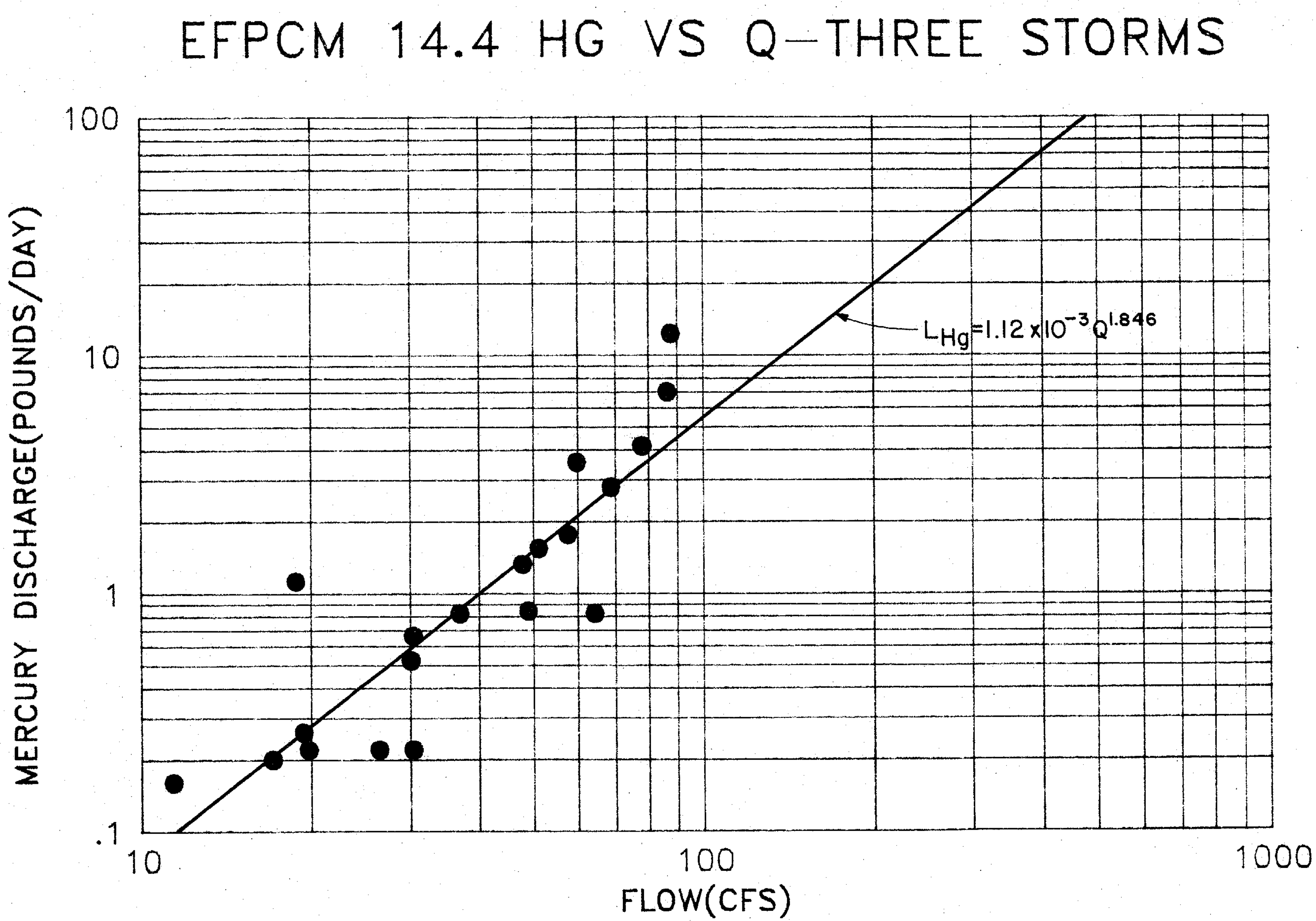

Figure 5: Total Mercury vs Discharge, EFPCM 14.4

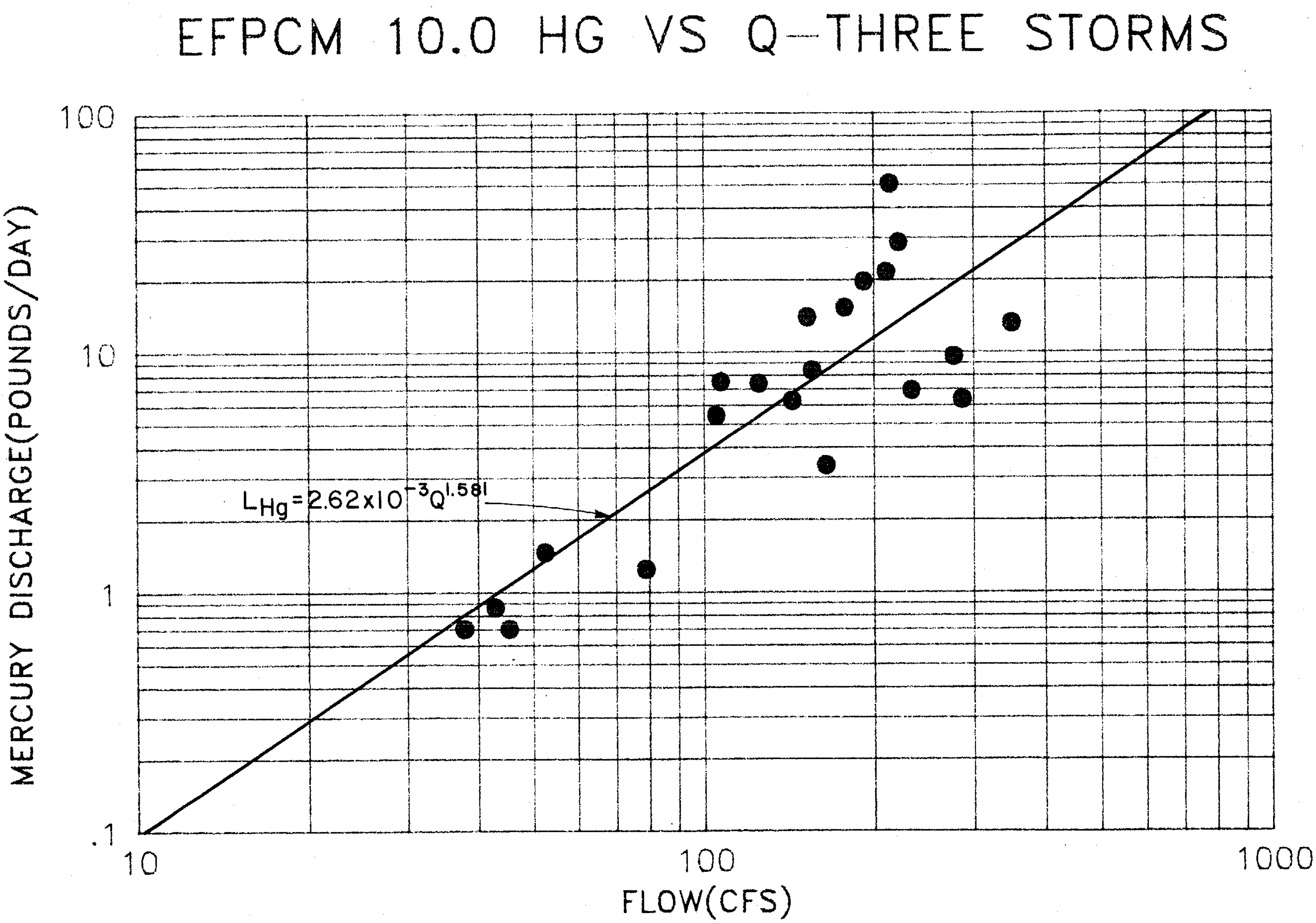

Figure 6: Total Mercury vs Discharge, EFPCM 10.0

TABLE 11

Total Mercury Versus Flow Regression Equations for
EFPCM 14.36 and 10.0
Instream Contaminant Study - Task 3

East Fork Poplar Creek Mile 14.4

$$L = 1.12 \times 10^{-3} Q^{1.846} \qquad r=0.87$$

East Fork Poplar Creek Mile 10.0

$$L = 2.62 \times 10^{-3} Q^{1.581} \qquad r=0.84$$

where: L = total mercury transport - pounds/day
Q = concurrent streamflow discharge - cfs
r = correlation coefficient

3.2.2 CALCULATED STORM LOADS

Since the hydrograph peak discharges measured during the third storm event (April 5-6, 1985) were similar to those measured during the second storm (November 10-11, 1984) only the first two storm events were used to compute storm mercury loads (see Table 7). Mercury transport graphs were developed by multiplying points along the hydrograph, depicted in Figures 3(a) and 3(b) in the Task 1 report, by the appropriate regression equation from Table 9 or Table 11. The graphs were integrated over the duration of each hydrograph to determine the load at each station for each storm. The results are presented in Table 12.

TABLE 12

Estimated Total Mercury Loads for the
October and November 1984 Storms
Instream Contaminant Study - Task 3

Station	October 22-23, 1984 THg Load-pounds	November 10-11, 1984 THg Load-pounds
EFPCM 14.36	2.6	1.0
EFPCM 10.0	7.4	4.7
EFPCM 3.3	5.8	4.7
BCM 0.55	.07	0.13

The loads presented in Table 12 should be considered as indicative of mercury transport during the first two storms, since the data collected during all three storms were composited to develop the mercury-flow rating functions. The purpose in determining these loads is to examine the transport relationships among the stations, rather than to estimate the actual loads which may have been transported during a particular storm.

Four observations are apparent from the storm loadings in Table 12. First, relative to the total watershed load there is a substantial suspended load of mercury at East Fork Poplar Creek mile 14.36 during storm periods, despite the fact the drainage area is only 1.69 square miles. Second, there is a significant increase in mercury load between stations EFPCM 14.36 and mile 10.0. During the October 1984 storm there was a threefold increase between the station at mile 14.36 and that at mile 10.0 while during the November storm the increase was some fivefold. The October storm had much higher relative discharges at the upper station which accounts for the smaller increase in mercury load between the two stations. In either case, the increase (which corresponds roughly to the fivefold increase in drainage area between the two stations) indicates that: (1) mercury-contaminated sediment which originated from New Hope Pond was resuspended; (2) mercury-contaminated sediment scour occurred between the two stations; (3) mercury-contaminated sediment was washed into the creek from the floodplain;

and/or (4) there are other sources of mercury between the stations. The third observation from Table 12 is that the similarities in loadings for the stations at mile 10.0 and mile 3.3 indicates that little, if any, additional mercury is added (or scoured) between these two stations. Relatively higher upstream discharges during the October 1984 storm and/or some deposition may account for the reduced load at mile 3.3 during that storm. Finally, Table 12 shows that Bear Creek is only a small contributor of mercury in comparison with East Fork Poplar Creek.

3.3 SCOUR AND DEPOSITION POTENTIAL ALONG EFPC

As can be seen from the data reported in the Task 2 report, the bulk of the mercury-contaminated sediment is located in the overbank, or floodplain areas along EFPC. Evaluation of the potential for mercury to be transported must therefore consider not only the channel but those overbank areas in which high mercury concentrations occur.

The channel system of East Fork Poplar Creek appears to transport very little sediment of bed-load size, and the fines which are transmitted are apparently washed through the system. The only fines which do not wash through are those which settle out in low-velocity areas of the channel (only to be resuspended during later high flow events) and those fines carried into floodplain areas which settle out.

3.3.1 APPROACH

Modeling this type of stream system requires the ability to predict detailed localized, overbank and instream scour and deposition patterns and detailed data on spatial variations in mercury concentration. In EFPC watershed mercury originates from a number of sources and the concentration of mercury-contaminated sediment is highly variable spatially and vertically. Existing models do not have the level of sophistication and accuracy necessary for handling this complicated a system nor are the necessary supporting data available. The overall potential for scour and deposition can be examined, however.

The U.S. Army Corps of Engineers model HEC-2N (10) was used to predict elevations, discharges, and velocities for the 2, 10, 50, 100, and 500-year recurrence floods. Discharges and velocities for the largest flood to have occurred since 1950 were also developed since only floods which occurred after 1950 could have deposited mercury-contaminated sediment in overbank areas. Coincidentially, the floodplains areas defined using either the largest floods since 1950 or 1940, which was the basis for estimating the quantity of mercury for Task 2 (section 3.1, vol. 1), are virtually identical.

The model was calibrated using existing profiles and rating curves from past studies. The profile for the largest flood since 1950 was a composite of several major storms (November 18, 1973, and April 4, 1977) and had a recurrence interval of approximately 30 years at mile 3.3 based upon the frequency information as presented in Section 1.3.2. Observed high water marks were used to develop the composite flood as no single storm was found to produce maximum elevations throughout the study reach. Cross sections used in the model were field surveyed at bridges and other strategic locations and were supplemented by cross sections developed using photogrammetric methods. Cross sections were taken at close intervals to compute water-surface elevations accurately (11).

Tables 13 and 14 show flood elevations and overbank and channel velocities for the largest flood since 1950 and the 500-year flood, respectively, as determined using the model. The river miles used in the tables correspond with the cross sections where mercury concentration data were obtained (see Appendix I of the Task 2 report).

TABLE 13

Floodplain and Channel Velocities for the
Maximum Flood Since 1950
East Fork Poplar Creek
Instream Contaminant Study - Task 3

Mile	Left Bank Ft/Sec	Channel Ft/Sec	Right Bank Ft/Sec	Water Surface Elevation
14.36	0.00	6.28	0.00	894.08
14.02	1.58	5.24	1.72	880.27
13.74	0.64	3.93	1.40	868.65
13.71	0.58	2.76	1.02	868.65
13.66	0.58	2.76	1.02	866.13
13.55	0.41	3.45	0.88	863.70
13.00	0.89	4.07	1.91	855.84
12.89	0.00	5.15	0.00	852.90
12.06	0.00	5.15	1.38	844.96
11.30	1.06	4.79	1.54	840.60
10.90	2.01	4.42	2.36	837.76
10.05	0.79	1.98	0.87	830.73
10.00	0.79	1.98	1.62	830.61
9.74	1.54	3.88	1.42	823.79
9.21	1.87	3.21	0.78	819.50
8.70	1.19	2.27	0.96	814.51
8.12	0.71	4.97	1.44	810.38
7.95	1.11	5.52	1.47	809.07
7.05	1.28	2.59	1.20	797.44
6.72	1.28	2.49	0.72	793.31
5.74	1.78	5.61	1.84	786.47
4.92	1.23	2.69	1.27	780.38
4.52	1.74	5.74	1.00	776.63
4.50	1.74	5.74	1.00	776.51
3.50	1.11	5.91	1.09	769.68
2.85	1.82	7.69	1.60	763.44
2.36	0.34	3.03	1.06	758.47
1.35	1.01	2.90	0.86	756.47
1.20	0.66	2.98	0.88	755.57
0.23	0.76	3.31	1.17	754.35

TABLE 14

Floodplain and Channel Velocities for the
500 Year Flood
East Fork Poplar Creek
Instream Contaminant Study - Task 3

Mile	Left Bank Ft/Sec	Channel Ft/Sec	Right Bank Ft/Sec	Water Surface Elevation
14.36	0.00	7.29	0.00	895.99
14.02	2.21	5.72	2.49	881.39
13.74	0.91	4.26	1.57	869.18
13.71	0.79	3.13	1.18	869.18
13.66	0.79	3.13	1.18	866.69
13.55	0.49	2.81	0.80	865.20
13.00	1.17	4.32	2.17	857.15
12.89	0.64	4.69	1.30	855.73
12.06	0.46	5.46	1.69	847.18
11.30	1.19	5.06	1.87	842.56
10.90	2.71	5.64	3.21	839.72
10.05	1.04	2.29	1.14	833.29
10.00	2.16	6.44	2.37	828.87
9.74	1.93	4.28	1.85	825.65
9.21	2.12	3.68	1.17	822.15
8.70	1.16	2.00	1.04	818.51
8.12	1.29	6.40	2.00	814.97
7.95	1.61	7.13	2.09	812.57
7.05	1.78	3.29	1.63	799.71
6.72	1.56	2.72	0.97	795.99
5.74	2.44	6.26	2.10	789.26
4.92	1.49	2.84	1.47	783.69
4.52	2.09	6.75	1.42	779.82
4.50	2.09	6.75	1.42	779.71
3.50	1.50	6.88	1.44	774.13
2.85	2.10	10.56	2.11	765.37
2.36	0.63	3.12	1.24	762.61
1.35	1.23	3.17	1.00	760.54
0.23	1.06	3.94	1.46	758.36

3.3.2 RESULTS OF COMPUTER MODELING

As explained above, the maximum flood elevations since 1950 represent the most extreme flows since the mercury releases began. Table 13 shows a maximum cross-section velocity of 7.69 feet per second in the main channel, and many locations with velocities in the range of four, five, or six feet per second. These velocities are ample to scour the loose sediment in the EFPC channel bed (12).

In contrast, Table 13 shows that overbank velocities were all below two feet per second except for the cross-section at EFPCM 10.90. Even here, the velocities were only 2.01 and 2.36 feet per second in the left and right floodplain, respectively.

Studies on stability of grass-lined channels (which would be comparable with vegetated floodplains of EFPC) have reported permissible velocities of 3.5 to 7 ft/sec before erosion begins, depending on type of vegetation, channel slope and erodibility of the soil (13). Soils in the East Fork Poplar Creek area are primarily silt loam (Hamblen and Newark soils) and relatively erosion resistant. Slopes in the floodplain are quite flat and the vegetative cover is heavy. Hence, based on this analogy the undisturbed overbank areas of EFPC should be relatively stable.

Figures 7 through 12 show cross sections at selected locations along East Fork Poplar Creek; mercury concentrations; relative water surface elevations for the maximum flood since 1950 and the 500 year flood; and the associated floodplain and main channel velocities. There is an apparent relationship between the extent of contaminated sediments and the flood levels experienced. An examination of the 500-year flood suggests that no significant change would occur in the depositional character of the floodplain, since the highest floodplain velocity predicted is slightly above three feet per second and still within a permissible design velocity for a grassed channel.

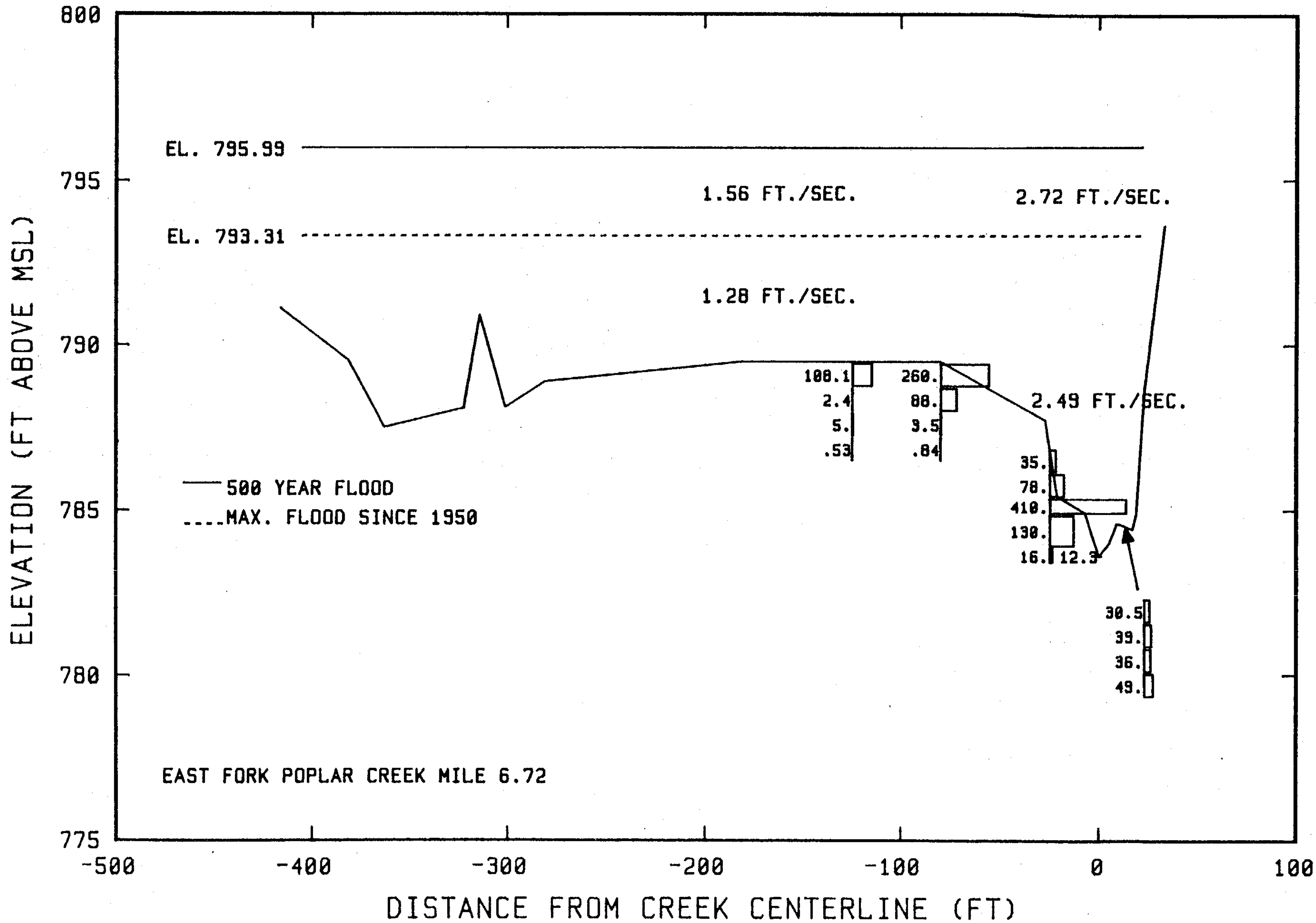

Figure 7: Flood Elevations, Velocities, and Mercury Concentrations; EFPCM 6.72

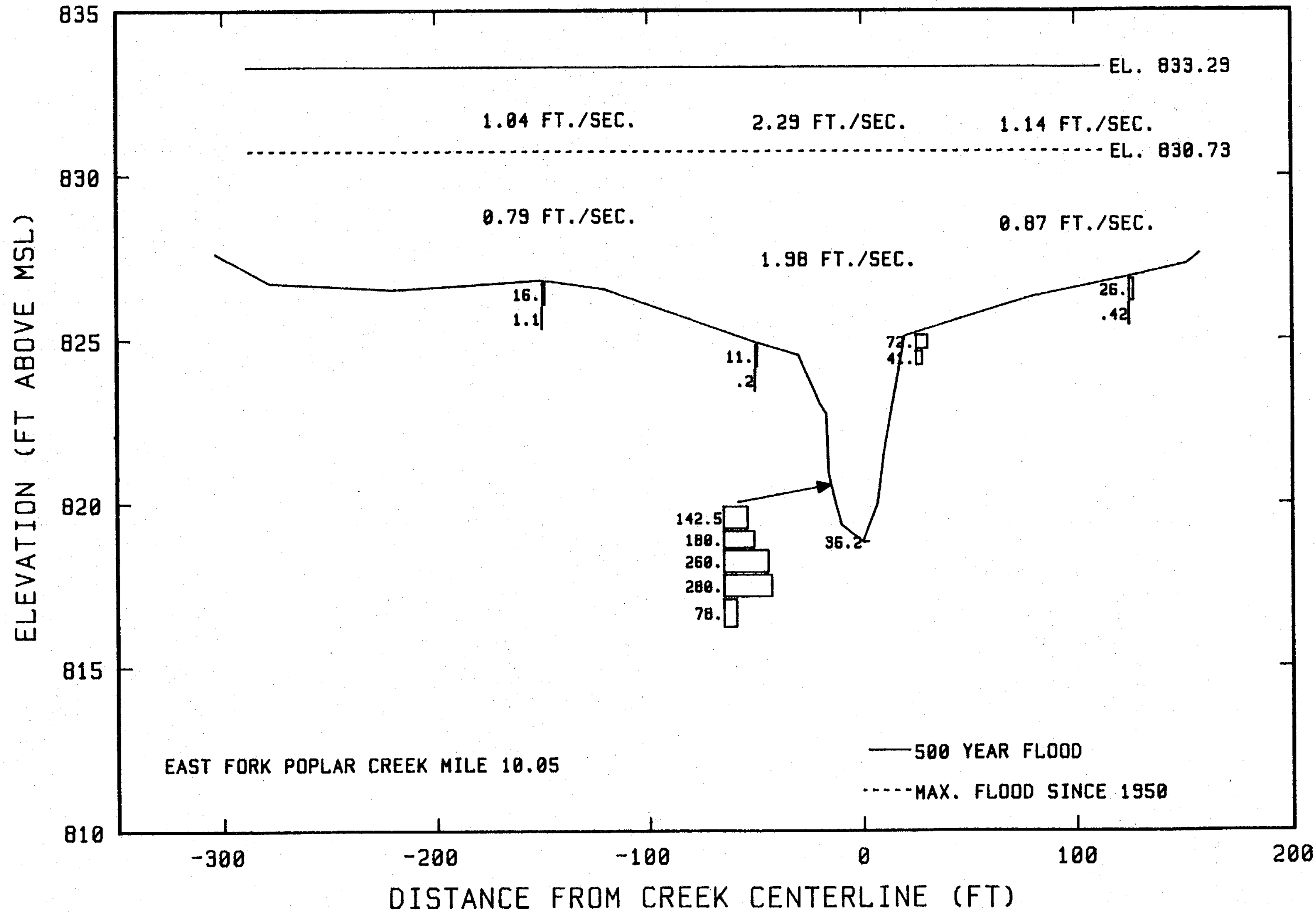

Figure 8: Flood Elevations, Velocities, and Mercury Concentrations; EFPCM 10.05

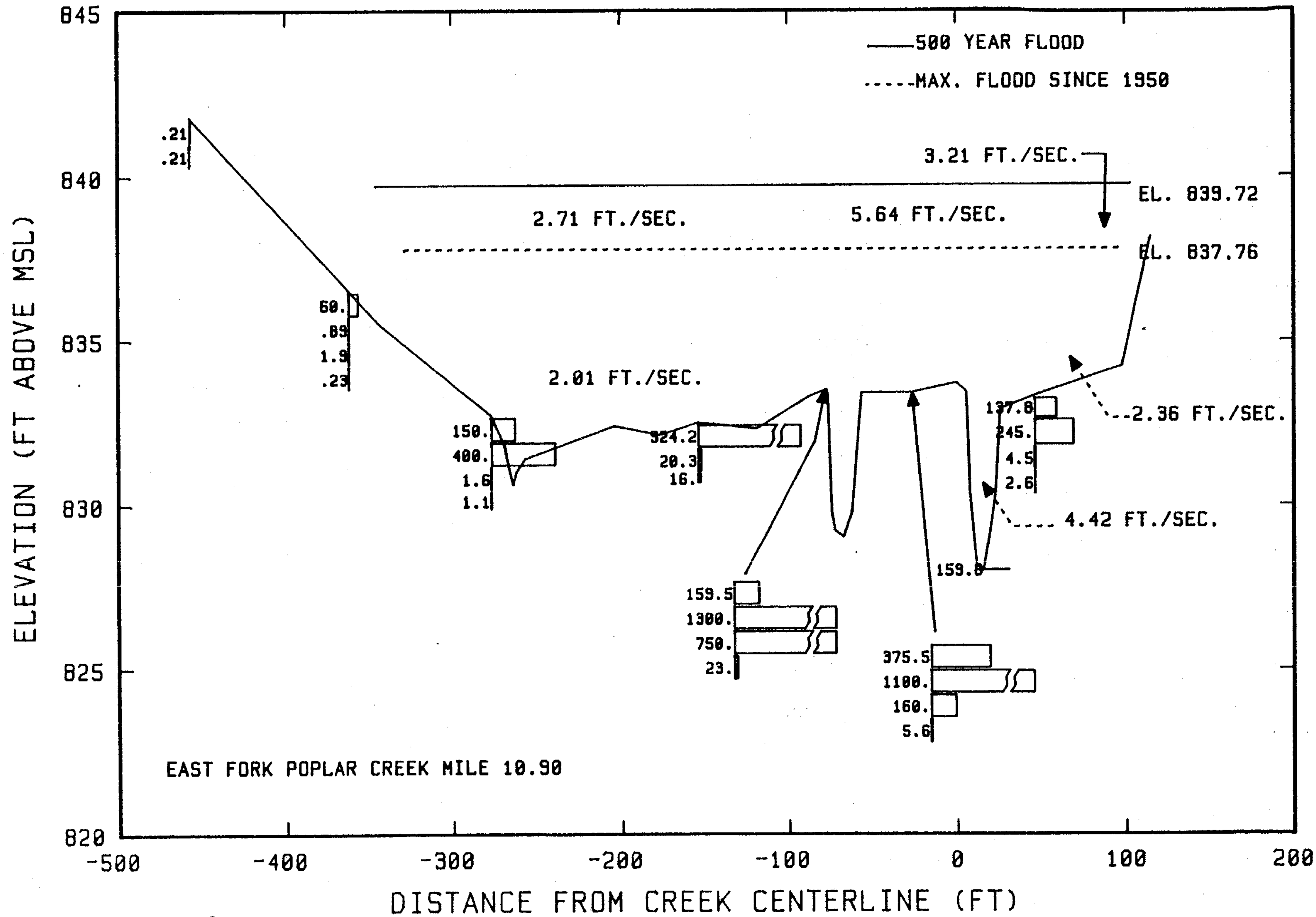

Figure 9: Flood Elevations, Velocities, and Mercury Concentrations; EFPCM 10.90

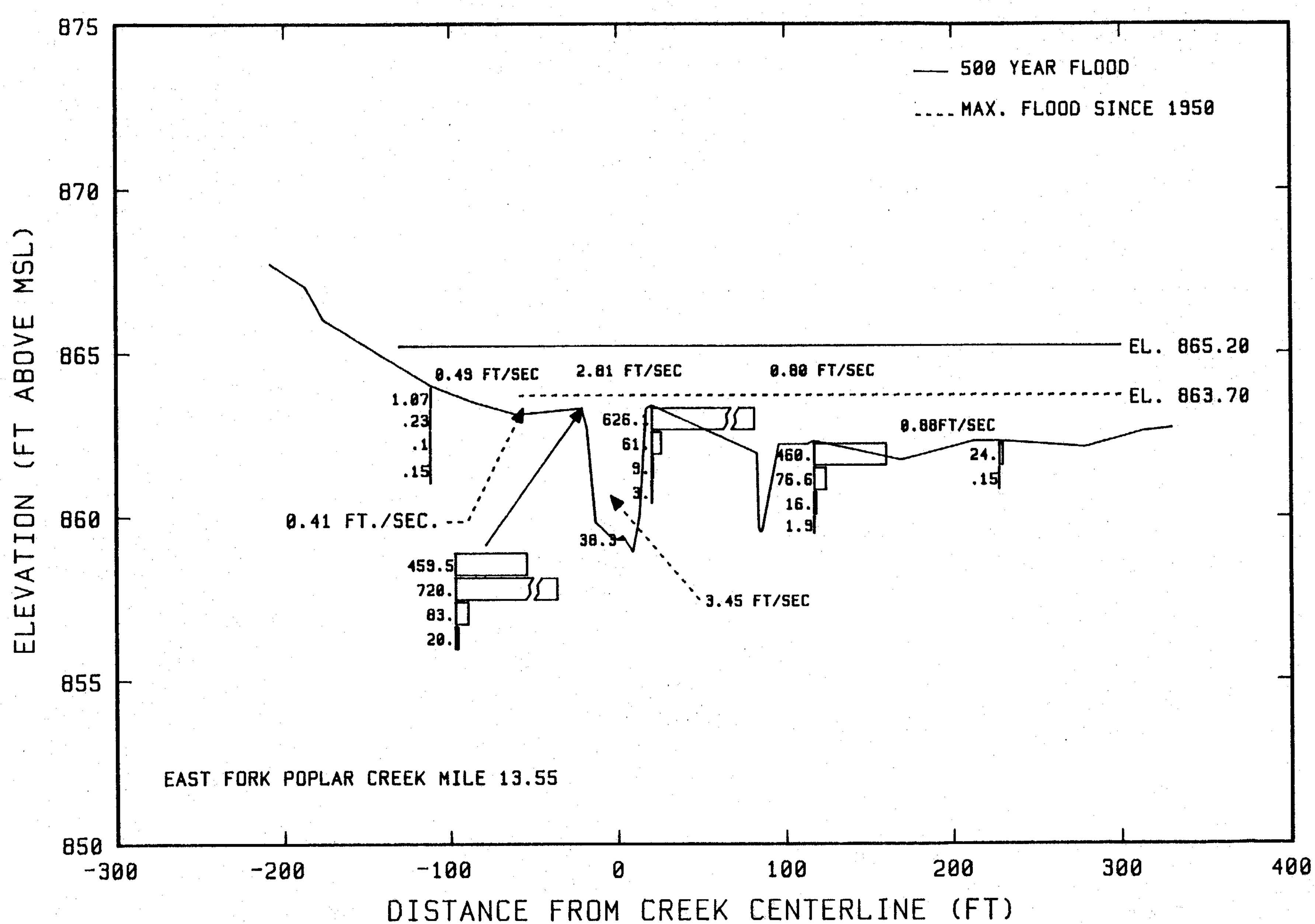

Figure 10: Flood Elevations, Velocities, and Mercury Concentrations; EFPCM 13.55

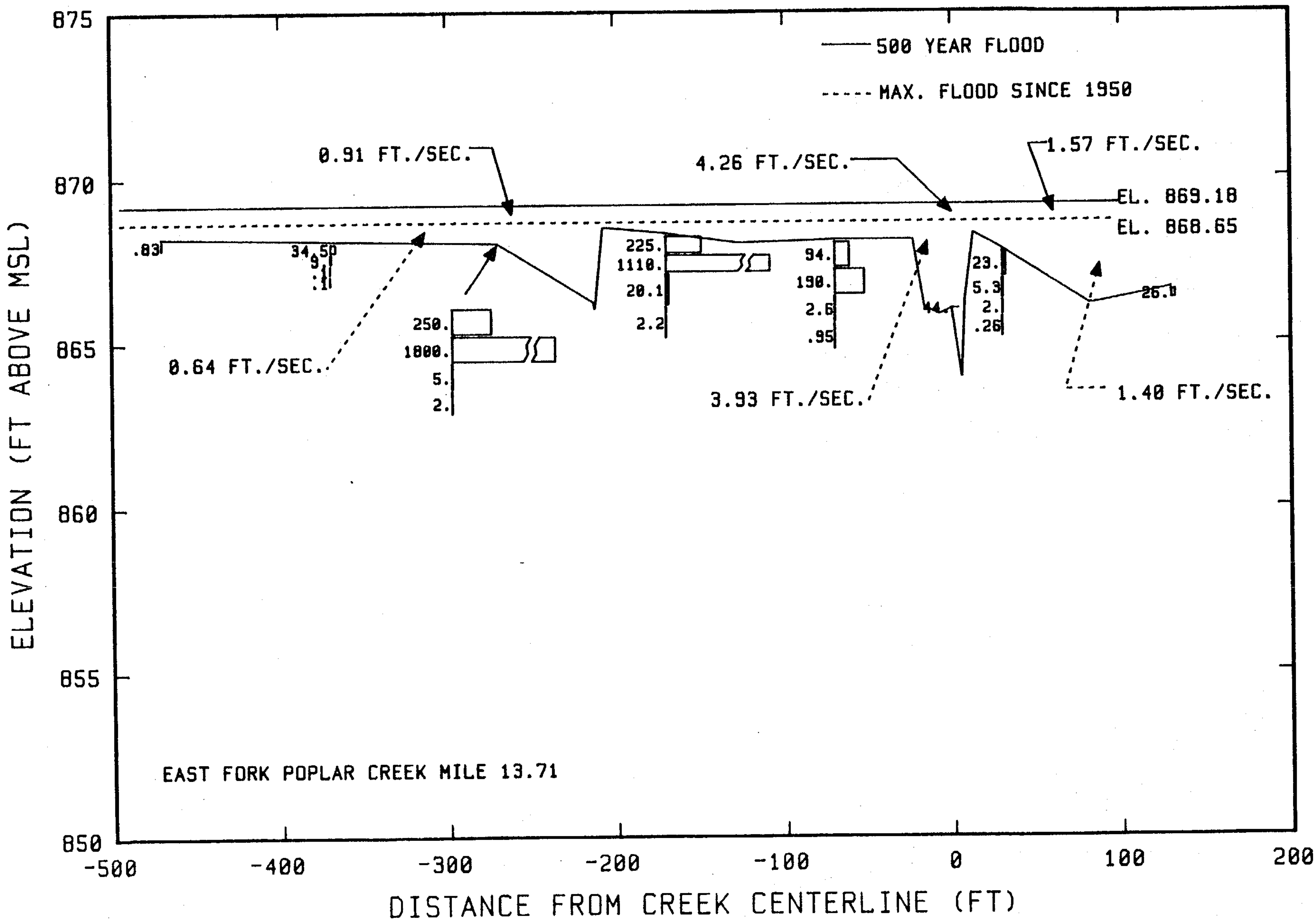

Figure 11: Flood Elevations, Velocities, and Mercury Concentrations; EFPCM 13.71

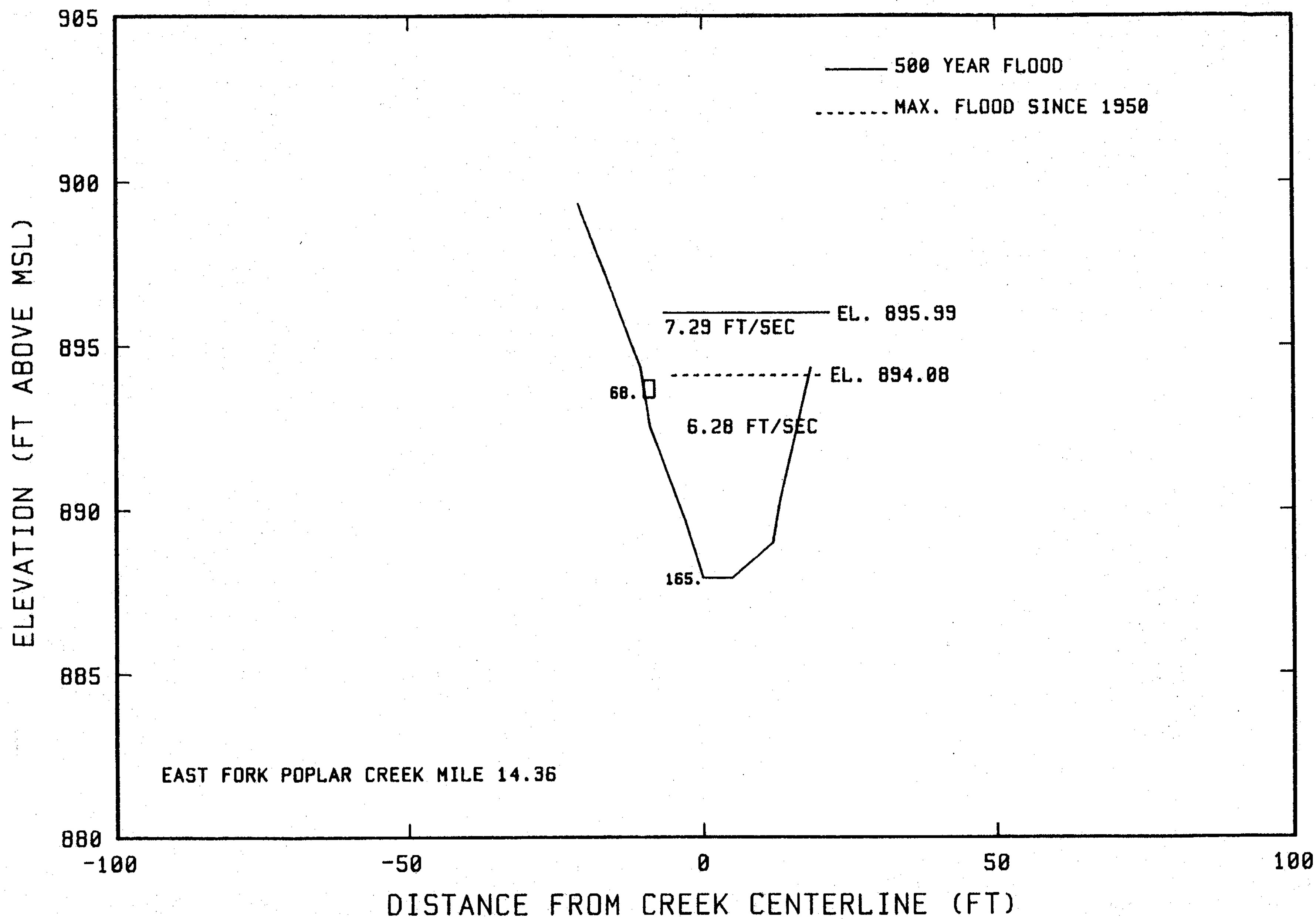

Figure 12: Flood Elevations, Velocities, and Mercury Concentrations; EFPCM 14.36

4.0 SUMMARY AND CONCLUSIONS

The water surface elevations and flow velocities computed for the maximum flood since 1950 clearly identify the undisturbed floodplain of East Fork Poplar Creek as a deposition zone, rather than a scour zone. Likely floodplain velocities are well within the permissible range for a stable floodplain. This stability is apparent from the high mercury concentrations and the substantial growth of vegetation in the overbank areas. The analysis also indicates that from the standpoint of flood flows, the floodplains are not likely to become scour zones, provided the floodplains remain relatively undisturbed.

Although the current floodplain is relatively stable, there are sections which are susceptible to development. Improper development, ground disturbance, or removal of vegetation will tend to increase flood velocities and increase the potential for erosion. The effect could accelerate scour of mercury-contaminated sediment from the floodplains. The channel banks are largely unvegetated at present, hence these banks are also susceptible to scour.

Section 3.1 indicated that sediment transport is relatively high in East Fork Poplar Creek. This appears to be associated with urban development and channel realignment within the city of Oak Ridge. The source of sediment transported during storm periods will vary, originating from natural erosion caused by overland flow (washload); washoff of accumulated debris in urban areas; channel and bank scour; and erosion from any disturbed areas such as construction sites. Because of the transitional nature of land disturbances in an urban area and the variability of storm runoff patterns, the origin of sediments transported downstream is variable, both during a storm and from storm to storm. This variability is reflected in the total suspended solids load versus discharge data shown in Figure 2. Similarly, the relationships shown in Figures 3 through 6 indicate there is considerable variability in the total mercury load-discharge data.

The predicted mercury loadings presented in Table 10 indicate that about 515 pounds of mercury are transported annually from EFPC at mile 3.3 and from Bear Creek. The near-constant mercury loads between EFPC mile 10.0 and mile 3.3 shown in Table 12 indicates additions to the load below mile 3.3 are unlikely; therefore, the 515 pounds/year of mercury probably approximates the net export from the entire watershed. This total is about 440 pounds greater than the estimated annual contributions from New Hope Pond. Since an estimated two percent of the approximately 160,000 pounds of floodplain mercury reside in channel sediments, there is an estimated 7-year supply of contaminated sediment in the channel alone. In addition, data presented in the Task 2 report and in Section 3.3 of this report show that the channel bank areas in many reaches contain high concentrations of mercury which are susceptible to erosion during flood periods. Urbanization can cause geomorphic changes which will accentuate bank erosion. Mercury-contaminated sediment will also be washed into the creek via overland flow. Thus the readily available supply of mercury-contaminated sediment is well in excess of 7 years. In fact, if the watershed were to continue to yield a net load of 440 pounds of mercury annually, it would take well over 300 years to deplete the estimated 160,000 pounds of mercury in the floodplain.

The computed annual loadings must be used with caution. Not only is there scatter in the load vs discharge data (shown in Figures 2 through 6) but the rating functions were extrapolated beyond the range of observed discharges. Additionally, rating functions derived from instantaneous water quality sample and flow data were applied to flow durations obtained using mean daily discharge data.

Section 3.2 of this report indicates that during the storms sampled, the reach of EFPC between miles 14.36 and 10.0, supplied a majority of the mercury transported. This reach contains the first large floodplain below New Hope Pond available for deposition. This is a site of considerable land disturbance and many impervious surfaces with high runoff capable of eroding mercury-contaminated soils. Whether the mercury loads predicted for EFPCM 14.36 for the two storms shown in Table 10 originated solely from current discharges from New Hope Pond or from local area runoff cannot be determined (the loadings for the October and November, 1984 storms were approximately equivalent to a 13-day and a 5-day discharge of mercury, respectively). Below EFPCM 10.0, it appears that little additional mercury was added, at least during storms of the magnitude sampled.

In summary, an estimated 160,000 pounds of mercury is believed to be contained in the floodplain and channel sediments of East Fork Poplar Creek. Section 3.3 indicates that predicted flow velocities in the floodplain are relatively low even during large, infrequent floods. Thus, the floodplain reaches are areas of past deposition and could continue to be sinks for future discharges, provided the floodplains are not disturbed.

In the absence of future external contributions of mercury to the watershed (e.g., New Hope Pond) gradual erosion of the channel and banks might be expected to produce a mercury load in the order of 400-500 pounds per year for some period of time. This load will diminish somewhat over time as the more easily-eroded contaminated sediments are removed. In any case, at the current rate the export of mercury from EFPC could be expected to continue for several hundred years because of the large amount contained in the floodplains. If the floodplains are improperly developed or disturbed, the mercury yield will increase in proportion to the area distrubed, the nature of the disturbance, its duration, and the concentration of the mercury-contaminated at the site of the disturbance.

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APPENDICES

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APPENDIX I

1.0 INTRODUCTION

A detailed description of the sampling stations and a summary of the parameters and procedures and methodology for the stormflow survey are provided in Instream Contaminant Study - Task 1, Water Sampling and Analysis, Office of Natural Resources and Economic Development, Tennessee Valley Authority, April 1985. The location and description of each stormflow sampling station are given in Table A1.

2.0 PROCEDURES AND METHODOLOGY

2.1 STORMFLOW SURVEY

Sampling of the third storm event was conducted on April 5-6, 1985. Rainfall began at approximately 4 p.m. on April 5 and ended at approximately 8 p.m. on the same day. Samples were collected from 10:30 p.m. on April 5 to 10:30 a.m. on April 6. The stormflow survey was initiated when rains were sufficient to maintain a stream stage of 0.70 feet at East Fork Poplar Creek Mile 14.36. The criteria for ending the storm was the recession of the creek stage at East Fork Poplar Creek Mile 3.3 to a predetermined level as measured by the station FW-2 streamflow recorder. Total rainfall during the storm event was 1.1 inches.

The PS 69 samples were removed from the sampler following the storm event. Samples collected at various times over the rising limb, peak, and receding limb of the hydrograph were selected for analysis (i.e., mercury, TSS, TVSS, and turbidity--Table A2).

Depth integrated samples for total suspended solids analyses were collected at all stations during the stormflow surveys. These samples were collected at three to five predetermined points across the stream and composited in a one-gallon sample container. At sites where PS 69 samplers were located (Table A1), depth integrated samples were collected at a minimum of three times over the duration of the storm event: once on the rising limb of the hydrograph, once near the peak, and once during the recession of stormflow. At sites with no PS 69 samplers, hourly depth integrated samples were collected. Samples for particle size analyses of suspended sediment were obtained by compositing equal volumes from the depth integrated samples collected at the site.

TABLE A1

Instream Contaminant Study - Storm No. 3
Stormflow Sampling Locations and Equipment Descriptions

Stream	Mile	Description	
		Site	Equipment Used
East Fork Poplar Creek	14.36	Below New Hope Pond division point into East Fork Poplar Creek	PS 69 automatic water sampler, FW-2 stream gage recorder and staff gage. Depth-integrated sampler.
East Fork Poplar Creek	10.00	Downstream of Wiltshire Drive bridge	Same as EFPCM 14.36 plus bedload sampler.
East Fork Poplar Creek	6.89	Downstream Side of Gum Hollow Road bridge at Oak Ridge Country Club Golf Course	FW-2 stream gage recorder and staff gage. Depth integrated and fixed stage water samplers.
East Fork Poplar Creek	3.30	USGS Gaging Station	Same as EFPCM 10.00 plus USGS stream gage.
East Fork Poplar Creek	0.03	Upstream of confluence with Poplar Creek	FW-2 stream gage recorder and staff gage. Depth integrated water sampler.
Mill Branch	0.20	Upstream 1000 ft of confluence with East Fork Poplar Creek	Same as EFPCM 6.89.
Bear Creek	0.55	Upstream from the influence from East Fork Poplar Creek backwater	Same as EFPCM 14.36.

TABLE A2

Instream Contaminant Study - Storm No. 3
Stormflow Analyses

Parameter	Sample Collection Method	Number of Analyses
Total Suspended Solids	Automatic PS 69	28
	Manual-Depth Integ.	34
	Fixed Stage	0
	Time Composite	7
		69
Total Volatile Suspended Solids	Automatic PS 69	28
	Manual-Depth Integ.	0
	Fixed Stage	0
	Total	28
Turbidity	Automatic PS 69	28
	Manual-Depth Integ.	0
	Fixed Stage	0
	Total	28
Mercury (Total and Dissolved)	Automatic PS 69	23
	Manual-Depth Integ.	6
	Total	29
Suspended Sediment Particle Size Analyses (mg/L greater than 63, 125, 500, and 2,000 micrometers)	Time Composite	7
Suspended Sediment Specific Gravity	Time Composite	7
Streamflow	FW-2 Stream Gage Recorder and Staff Gage	Continuous Record

All samples for laboratory analyses were processed in the field (e.g., filtration, preservation) and shipped on ice to the TVA Laboratory Branch in Chattanooga for analysis and further distribution.

3.0 RESULTS AND DISCUSSION

3.1 STORMFLOW SURVEYS

Results for the third stormflow survey are given in Appendix II. The following discussion compares the mercury concentrations during the storm event with available standards and criteria. Streamflow and suspended sediment data are examined relative to their potential impact on sediment transport.

3.1.1 STREAMFLOW

Figure A1 presents hydrographs for the rated stations during the third storm event. A hydrograph for East Fork Poplar Creek Mile 0.03 was not obtained due to the pool effects of Watts Bar Reservoir. Detailed (expanded scale) plots of each hydrograph and the water levels at East Fork Poplar Creek Mile 0.03 are given in Appendix III. (Figures A2-A8).

3.1.2 PHYSICAL CHARACTERISTICS OF SUSPENDED SEDIMENT

The specific gravities and particle size analyses results for 7 suspended sediment samples collected during the storm event is given in Table A3. The specific gravities of suspended sediment ranged from 1.62 to 2.89.

Particle size analyses results for suspended sediment (Table A3) show that the concentrations were typically in the size range less than 63 mm.

3.1.3 SUSPENDED SEDIMENT

The results of total and volatile suspended solids and turbidity analyses are presented in Appendix II. Sixty-nine samples were collected for total suspended solids analyses, 28 were collected for volatile suspended solids analyses, and 28 were collected for turbidity analyses.

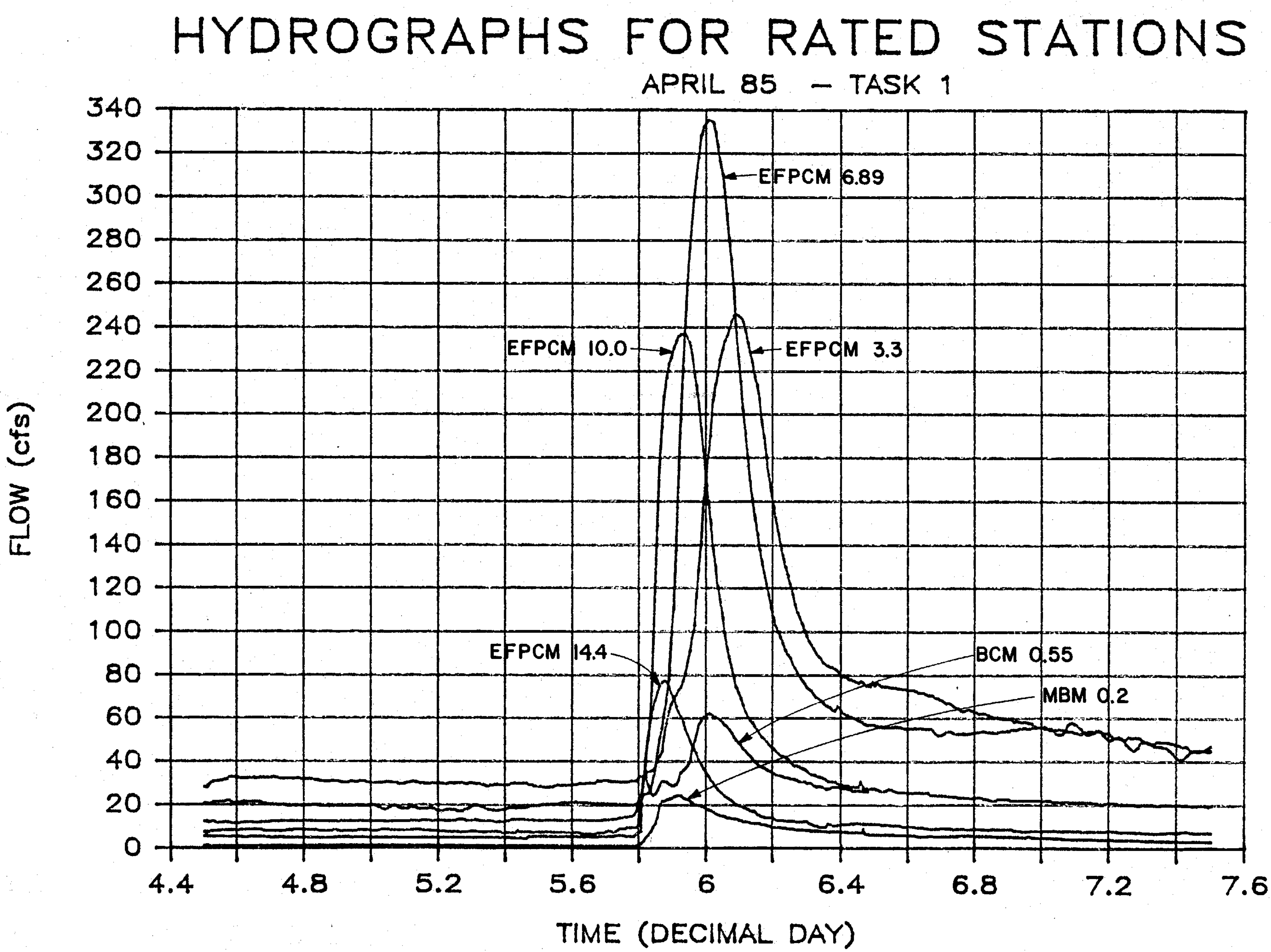

Figure A1: Hydrographs for Rated Stations April 1985

TABLE A3

Instream Contaminant Study - Storm No. 3, April 5-6
Stormflow Sampling - Physical Characteristics
of Suspended Sediment

Stream mg/L	Mile	Gravity	Concentration of Suspended Sediment mg/L Greater Than Given Size 2000 mm	500 mm	125 mm	63 mm	Total Suspended Solids
East Fork Poplar	14.36	2.89	<0.1	<0.1	1.7	2.2	115.0
Creek	10.0	*	<0.1	0.4	1.6	7.2	269.0
	6.89	2.16	<0.1	1.2	38.1	102.0	271.0
	3.3	1.62	1.1	3.7	38.1	139.0	448.0
	0.03	1.74	<0.1	0.9	22.2	85.8	360.0
Bear Creek	0.55	2.59	<0.1	0.2	2.2	5.9	433.0
Mill Branch	0.20	1.71	<0.1	<0.1	<0.1	2.0	36.0

* - questionable analysis

Figures A9 through A15 of Appendix III presents graphs of total suspended solids and streamflow versus time for the duration of stormflow sampling for the third storm event. These graphs show that generally total suspended solids concentrations were directly proportional to streamflow. Turbidity values generally increased with increases in total suspended solids and streamflow.

3.1.4 MERCURY

The results of total and dissolved mercury analyses for 29 samples collected during the third storm event are presented in Appendix III. Figure A16 through A19 of Appendix II presents graphs of total mercury and streamflow versus time for the third storm event. These graphs also show the instances where total mercury concentrations were above the EPA Primary Drinking Water Standard of 2 mg/L and the EPA Water Quality criteria for the Protection of Aquatic Life (24-hour average) of 0.2 mg/L. Total mercury concentrations for East Fork Poplar Creek were at or above both the drinking water standard and the water quality criteria for aquatic life for most samples collected during the storm event. Total mercury concentrations for Bear Creek were below the drinking water standard but at or above the water quality criteria for aquatic life. The maximum total mercury concentration was 44 mg/L for East Fork Poplar Creek Mile 10.0 during the storm event. Dissolved mercury concentrations (Appendix II) were all below the analytical detection limit of 0.2 mg/L.

APPENDIX II

STORET RETRIEVAL DATE 85/06/25

476507
35 59 49.3 084 14 27.3 1
BELOW NEW HOPE POND DIVERSION POINT
47001 TENNESSEE ANDERSON
CLINCH RIVER BASIN 040102
EAST FORK POPLAR CREEK 14.36
132TVAC 840601
0000 FEET DEPTH
DATA LOCKED AFTER 84/05.

/TYPA/AMBNT/STREAM

INDEX 1021500 007720 00920 7930 0610 0080
MILES 0953.80 0046.50 567.70 012.00 005.47 014.36

DATE FROM TO	TIME OF DAY	MEDIA CODE	SMK OR DEPTH (FEET)	00008 LAB IDENT. NUMBER	84068 SERIES CODE ALPHA	00063 NO. OF SAMPLING POINTS	00065 STREAM STAGE FEET	82079 TURBIDTY LAB NTU	00530 RESIDUE TOT NFLT MG/L	00535 RESIDUE VOL NFLT MG/L	71821 SPECIFIC GRAVITY SEDGM/GM	71890 MERCURY HG,DISS UG/L	71900 MERCURY HG,TOTAL UG/L
85/04/05	2133	WATER		12124	2A	1		190.0	210	48			
85/04/05	2139	WATER		12152	3A	1						.2U	7.5
85/04/05	2218	WATER		12125	11A	1		130.0	120	29			
85/04/05	2223	WATER		12153	12A	1						.2U	5.7
85/04/05	2225	WATER		12084	40D	3	.97		160			.2U	11.0
85/04/05	2340	WATER		12126	25A	1		110.0	100	26			
85/04/05	2345	WATER		12154	26A	1						.2U	4.1
85/04/06	0030	WATER		12085	41D	3	.60		120				
85/04/06	0031	WATER		12127	33A	1		130.0	110	26			
85/04/06	0035	WATER		12155	34A	1						.2U	4.0
85/04/06	0230	WATER		12156	53A	1						.2U	2.5
85/04/06	0235	WATER		12086	42D	3	.40		75				
85/04/05 2225 CP(B)-G 85/04/06 0235		WATER			0K4D	3			115		2.89		
85/04/06	0236	WATER		12128	54A	1		90.0	73	23			
85/04/06	0515	WATER		12129	67A	1		70.0	58	14			
85/04/06	0915	WATER		12157	16A	1						.2U	2.5
85/04/06	0927	WATER		12130	17A	1		32.0	33	8			

STORET RETRIEVAL DATE 85/06/25

476507
35 59 49.3 084 14 27.3 1
BELOW NEW HOPE POND DIVERSION POINT
47001 TENNESSEE ANDERSON
CLINCH RIVER BASIN 040102
EAST FORK POPLAR CREEK 14.36
132TVAC 840601
0000 FEET DEPTH
DATA LOCKED AFTER 84/05.

/TYPA/AMBNT/STREAM

INDEX 1021500 007720 00920 7930 0610 0080
MILES 0953.80 0046.50 567.70 012.00 005.47 014.36

DATE FROM TO	TIME OF DAY	MEDIA CODE	SMK OR DEPTH (FEET)	80325 SUS PART > 63U MG/L	80322 SUS PART >125U MG/L	80328 SUS PART GT500UM MG/L	80326 SUS PART >2000 UM MG/L
85/04/05 2225 CP(B)-G 85/04/06 0235		WATER		2.2	1.7	.1K	.1K

STORET RETRIEVAL DATE 85/06/25 PAGE: 3

476508
35 59 55.0 084 18 00.6 1
BRIDGE AT WILTSHIRE
47001 TENNESSEE ANDERSON
CLINCH RIVER BASIN 040102
EAST FORK POPLAR CREEK 10.0
132TVAC 840601

/TYPA/AMBNT/STREAM

INDEX 1021500 007720 00920 7930 0610 0080
MILES 0953.80 0046.50 567.70 012.00 005.47 010.00

0000 FEET DEPTH
DATA LOCKED AFTER 84/05.

DATE FROM TO	TIME OF DAY	MEDIA CODE	SMK OR DEPTH (FEET)	00008 LAB IDENT. NUMBER	84068 SERIES CODE ALPHA	00063 NO. OF SAMPLING POINTS	00065 STREAM STAGE FEET	82079 TURBIDTY LAB NTU	00530 RESIDUE TOT NFLT MG/L	00535 RESIDUE VOL NFLT MG/L	71821 SPECIFIC GRAVITY SEDGM/GM	71890 MERCURY HG,DISS UG/L	71900 MERCURY HG,TOTAL UG/L
85/04/05	2155	WATER		12131	2A	1		70.0	98	19			
85/04/05	2200	WATER		12158	3	1						.2U	5.5
85/04/05	2240	WATER		12132	10A	1		335.0	420	57			
85/04/05	2245	WATER		12087	30D	5	2.90		440				
85/04/05	2312	WATER		12133	16A	1		370.0	450	63			
85/04/05	2315	WATER		12088	31D	5	3.08		490			.2U	44.0
85/04/05	2319	WATER		12159	17	1						.2U	19.0
85/04/06	0010	WATER		12134	26A	1		320.0	380	56			
85/04/06	0015	WATER		12089	32D	5	2.40		330				
85/04/06	0016	WATER		12160	27	1						.2U	17.0
85/04/06	0107	WATER		12161	36	1						.2U	13.0
85/04/06	0112	WATER		12135	37A	1		310.0	280	44			
85/04/06	0115	WATER		12090	33D	5	1.90		200			.2U	9.6
85/04/06	0220	WATER			34D	5	1.52						
85/04/06	0348	WATER		12136	61A	1		155.0	140	23			
85/04/06	0350	WATER		12091	35D	5	1.25		40				
85/04/06	0650	WATER		12162	2	1						.2U	3.4
85/04/06	0701	WATER		12137	6A	1		90.0	74	14			
85/04/06	0710	WATER			36D	5	1.00						
85/04/05 CP(B)-G 85/04/06	2245 0710	WATER			OK10D				269		5.18		

STORET RETRIEVAL DATE 85/06/25 PAGE: 4

476508
35 59 55.0 084 18 00.6 1
BRIDGE AT WILTSHIRE
47001 TENNESSEE ANDERSON
CLINCH RIVER BASIN 040102
EAST FORK POPLAR CREEK 10.0
132TVAC 840601

/TYPA/AMBNT/STREAM

INDEX 1021500 007720 00920 7930 0610 0080
MILES 0953.80 0046.50 567.70 012.00 005.47 010.00

0000 FEET DEPTH
DATA LOCKED AFTER 84/05.

DATE FROM TO	TIME OF DAY	MEDIA CODE	SMK OR DEPTH (FEET)	80325 SUS PART > 63U MG/L	80322 SUS PART >125U MG/L	80328 SUS PART GT500UM MG/L	80326 SUS PART >2000 UM MG/L
85/04/05 CP(B)-G 85/04/06	2245 0710	WATER		7.2	1.6	.4	.1K

STORET RETRIEVAL DATE 85/06/25

476509
35 58 57.0 084 19 39.0 2
GUM HOLLOW BRIDGE AT OAK RIDGE COUNTRY CLUB
47145 TENNESSEE ROANE
CLINCH RIVER BASIN 040102
EAST FORK POPLAR CREEK 6.89
132TVAC 840601
0000 FEET DEPTH
DATA LOCKED AFTER 84/05.

/TYPA/AMBNT/STREAM

INDEX 1021500 007720 00920 7930 0610 0080
MILES 0953.80 0046.50 567.70 012.00 005.47 006.89

DATE FROM TO	TIME OF DAY	MEDIA CODE	SMK OR DEPTH (FEET)	00008 LAB IDENT. NUMBER	84068 SERIES CODE ALPHA	00063 NO. OF SAMPLING POINTS	00065 STREAM STAGE FEET	82079 TURBIDTY LAB NTU	00530 RESIDUE TOT NFLT MG/L	00535 RESIDUE VOL NFLT MG/L	71821 SPECIFIC GRAVITY SEDGM/GM	71890 MERCURY HG,DISS UG/L	71900 MERCURY HG,TOTAL UG/L
85/04/06	0001	WATER		12092	27D	5	3.65		890				
85/04/06	0100	WATER		12093	28D	5	3.65		520				
85/04/06	0200	WATER		12094	29D	5	3.20		410				
85/04/06	0300	WATER		12095	30D	5	2.50		270				
85/04/06	0400	WATER			31D	5	2.00						
85/04/06	0500	WATER		12096	32D	5	1.70		140				
85/04/06	0600	WATER			33D	5	1.50						
85/04/06	0700	WATER			34D	5	1.35						
85/04/06	0800	WATER			35D	5	1.28						
85/04/06	0900	WATER		12097	36D	5	1.25		40				
85/04/06	1000	WATER			37D	5	1.25						
85/04/06	0001												
CP(B)-G		WATER			OK11D	5			271		2.16		
85/04/06	1000												

STORET RETRIEVAL DATE 85/06/25

476509
35 58 57.0 084 19 39.0 2
GUM HOLLOW BRIDGE AT OAK RIDGE COUNTRY CLUB
47145 TENNESSEE ROANE
CLINCH RIVER BASIN 040102
EAST FORK POPLAR CREEK 6.89
132TVAC 840601
0000 FEET DEPTH
DATA LOCKED AFTER 84/05.

/TYPA/AMBNT/STREAM

INDEX 1021500 007720 00920 7930 0610 0080
MILES 0953.80 0046.50 567.70 012.00 005.47 006.89

DATE FROM TO	TIME OF DAY	MEDIA CODE	SMK OR DEPTH (FEET)	80325 SUS PART > 63U MG/L	80322 SUS PART >125U MG/L	80328 SUS PART GT500UM MG/L	80326 SUS PART >2000 UM MG/L
85/04/06	0001						
CP(B)-G		WATER		102.0	38.1	1.2	.1K
85/04/06	1000						

STORET RETRIEVAL DATE 85/06/25 PAGE: 7

476510
35 57 58.0 084 21 31.0 2
USGS GAGING STATION - BRIDGE 2.3 M NNE OF WHEAT
47145 TENNESSEE ROANE
CLINCH RIVER BASIN 040102
EAST FORK POPLAR CREEK 3.3
132TVAC 840601

/TYPA/AMBNT/STREAM

INDEX 1021500 007720 00920 7930 0610 0080
MILES 0953.80 0046.50 567.70 012.00 005.47 003.30

0000 FEET DEPTH
DATA LOCKED AFTER 84/05.

DATE FROM TO	TIME OF DAY	MEDIA CODE	SMK OR DEPTH (FEET)	00008 LAB IDENT. NUMBER	84068 SERIES CODE ALPHA	00063 NO. OF SAMPLING POINTS	00065 STREAM STAGE FEET	82079 TURBIDTY LAB NTU	00530 RESIDUE TOT NFLT MG/L	00535 RESIDUE VOL NFLT MG/L	71821 SPECIFIC GRAVITY SEDGM/GM	71890 MERCURY HG,DISS UG/L	71900 MERCURY HG,TOTAL UG/L
85/04/05	2327	WATER		12138	6A	1		135.0	170	22			
85/04/05	2348	WATER		12104	10D	5	3.10		440				
85/04/06	0000	WATER		12139	9A	1		250.0	260	32			
85/04/06	0010	WATER		12163	10A	1						.2U	3.7
85/04/06	0113	WATER		12140	16A	1		230.0	290	37			
85/04/06	0120	WATER		12105	11D	5	3.80		640			.2U	16.0
85/04/06	0125	WATER		12164	17A	1						.2U	6.3
85/04/06	0242	WATER		12141	24A	1		315.0	380	59			
85/04/06	0250	WATER		12106	12D	5	3.85		770			.2U	16.0
85/04/06	0252	WATER		12165	25A	1						.2U	11.0
85/04/06	0455	WATER		12142	36A	1		280.0	320	87			
85/04/06	0507	WATER		12166	37A	1						.2U	9.2
85/04/06	0722	WATER		12143	47A	1		190.0	220	40			
85/04/06	0730	WATER		12107	13D	5	2.68		140				
85/04/05 CP(B)-G 85/04/06	2348 0730	WATER			0K12D				448		1.62		
85/04/06	0920	WATER		12167	56A	1						.2U	5.0
85/04/06	0931	WATER		12144	57A	1		150.0	140	32			

STORET RETRIEVAL DATE 85/06/25 PAGE: 8

476510
35 57 58.0 084 21 31.0 2
USGS GAGING STATION - BRIDGE 2.3 M NNE OF WHEAT
47145 TENNESSEE ROANE
CLINCH RIVER BASIN 040102
EAST FORK POPLAR CREEK 3.3
132TVAC 840601

/TYPA/AMBNT/STREAM

INDEX 1021500 007720 00920 7930 0610 0080
MILES 0953.80 0046.50 567.70 012.00 005.47 003.30

0000 FEET DEPTH
DATA LOCKED AFTER 84/05.

DATE FROM TO	TIME OF DAY	MEDIA CODE	SMK OR DEPTH (FEET)	80325 SUS PART > 63U MG/L	80322 SUS PART >125U MG/L	80328 SUS PART GT500UM MG/L	80326 SUS PART >2000 UM MG/L
85/04/05 CP(B)-G 85/04/06	2348 0730	WATER		139.0	38.1	3.7	1.1

STORET RETRIEVAL DATE 85/06/25

476608
35 56 58.0 084 23 13.0 2
TRIBUTARY TO POPLAR CREEK 5.47
47145 TENNESSEE ROANE
CLINCH RIVER BASIN 040102
EAST FORK POPLAR CREEK 0.03
132TVAC 841103
0000 FEET DEPTH
DATA LOCKED AFTER 84/05.

/TYPA/AMBNT/STREAM

INDEX 1021500 007720 00920 7930 0610 0080
MILES 0953.80 0046.50 567.70 012.00 005.47 000.03

DATE FROM TO	TIME OF DAY	MEDIA CODE	SMK OR DEPTH (FEET)	00008 LAB IDENT. NUMBER	84068 SERIES CODE ALPHA	00063 NO. OF SAMPLING POINTS	00065 STREAM STAGE FEET	82079 TURBIDTY LAB NTU	00530 RESIDUE TOT NFLT MG/L	00535 RESIDUE VOL NFLT MG/L	71821 SPECIFIC GRAVITY SEDGM/GM	71890 MERCURY HG,DISS UG/L	71900 MERCURY HG,TOTAL UG/L
85/04/05	2230	WATER		12108	27D	3	1.20		66			.2U	2.3
85/04/05	2330	WATER			28D	3	1.20						
85/04/06	0030	WATER		12109	29D	4	1.28		170				
85/04/06	0130	WATER			30D	4	1.40						
85/04/06	0230	WATER		12110	31D	4	1.60		560			.2U	12.0
85/04/06	0330	WATER			32D	4	1.64						
85/04/06	0430	WATER		12111	33D	4	1.75		580			.2U	19.0
85/04/06	0600	WATER		12112	34D	4	1.82		420			.2U	12.0
85/04/06	0740	WATER			35D	4	1.78						
85/04/06	0830	WATER			36D	4	1.70						
85/04/06	0930	WATER		12113	37D	4	1.65		150				
85/04/06	1030	WATER			38D	4	2.22						
85/04/05	2230												
CP(B)-G		WATER			OM13D				360		1.74		
85/04/06	1030												

STORET RETRIEVAL DATE 85/06/25

476608
35 56 58.0 084 23 13.0 2
TRIBUTARY TO POPLAR CREEK 5.47
47145 TENNESSEE ROANE
CLINCH RIVER BASIN 040102
EAST FORK POPLAR CREEK 0.03
132TVAC 841103
0000 FEET DEPTH
DATA LOCKED AFTER 84/05.

/TYPA/AMBNT/STREAM

INDEX 1021500 007720 00920 7930 0610 0080
MILES 0953.80 0046.50 567.70 012.00 005.47 000.03

DATE FROM TO	TIME OF DAY	MEDIA CODE	SMK OR DEPTH (FEET)	80325 SUS PART > 63U MG/L	80322 SUS PART >125U MG/L	80328 SUS PART GT500UM MG/L	80326 SUS PART >2000 UM MG/L
85/04/05	2230						
CP(B)-G		WATER		85.8	22.2	.9	.1K
85/04/06	1030						

STORET RETRIEVAL DATE 85/06/25 PAGE: 9

476512
35 59 45.0 084 18 03.0 2
TRIBUTARY TO EAST FORK POPLAR CREEK 9.66
47001 TENNESSEE ANDERSON
CLINCH RIVER BASIN 040102
MILL BRANCH 0.20
132TVAC 840601

/TYPA/AMENT/STREAM

INDEX 1021500 007720 00920 7930 0610 0080 0360
MILES 0953.80 0046.50 567.70 012.00 005.47 005.66 00.20

0000 FEET DEPTH
DATA LOCKED AFTER 84/05.

DATE FROM TO	TIME OF DAY	MEDIA CODE	SMK OR DEPTH (FEET)	00008 LAB IDENT. NUMBER	84068 SERIES CODE ALPHA	00063 NO. OF SAMPLING POINTS	00065 STREAM STAGE FEET	82079 TURBIDTY LAB NTU	00530 RESIDUE TOT NFLT MG/L	00535 RESIDUE VOL NFLT MG/L	71821 SPECIFIC GRAVITY SEDGM/GM	71890 MERCURY HG,DISS UG/L	71900 MERCURY HG,TOTAL UG/L
85/04/05	2330	WATER			28D	3	1.89						
85/04/06	0030	WATER		12114	29D	3	1.80		47				
85/04/06	0130	WATER			30D	3	1.74						
85/04/06	0230	WATER		12115	31D	3	1.68		9				
85/04/06	0330	WATER			32D	3	1.65						
85/04/06	0430	WATER		12116	33D	3	1.64		18				
85/04/06	0530	WATER			34D	3	1.63						
85/04/06	0630	WATER			35D	3	1.62						
85/04/06	0730	WATER		12117	36D	3	1.60		6				
85/04/06	0830	WATER			37D	3	1.59						
85/04/06	0930	WATER		12118	38D	3	1.58		1K				
85/04/06	1030	WATER			39D	3	1.57						
85/04/05	2330												
CP(B)-G		WATER			OK14D	3			36		1.71		
85/04/06	1030												

STORET RETRIEVAL DATE 85/06/25 PAGE: 10

476512
35 59 45.0 084 18 03.0 2
TRIBUTARY TO EAST FORK POPLAR CREEK 9.66
47001 TENNESSEE ANDERSON
CLINCH RIVER BASIN 040102
MILL BRANCH 0.20
132TVAC 840601

/TYPA/AMBNT/STREAM

INDEX 1021500 007720 00920 7930 0610 0080 0360
MILES 0953.80 0046.50 567.70 012.00 005.47 009.66 00.20

0000 FEET DEPTH
DATA LOCKED AFTER 84/05.

DATE FROM TO	TIME OF DAY	MEDIA CODE	SMK OR DEPTH (FEET)	80325 SUS PART > 63U MG/L	80322 SUS PART >125U MG/L	80328 SUS PART GT500UM MG/L	80326 SUS PART >2000 UM MG/L
85/04/05	2330						
CP(B)-G		WATER		2.0	.1K	.1K	.1K
85/04/06	1030						

476515
35 56 49.4 084 22 01.2 1
UPSTREAM FROM THE INFLUENCE OF EFPC BACKWATER
47145 TENNESSEE ROANE
CLINCH RIVER BASIN 040102
BEAR CREEK 0.55
132TVAC 840601
0000 FEET DEPTH
DATA LOCKED AFTER 84/05.

/TYPA/AMENT/STREAM

INDEX 1021500 007720 00920 7930 0610 0080 0020
MILES 0953.80 0046.50 567.70 012.00 005.47 001.47 00.55

DATE FROM TO	TIME OF DAY	MEDIA CODE	SMK OR DEPTH (FEET)	00008 LAB IDENT. NUMBER	84068 SERIES CODE ALPHA	00063 NO. OF SAMPLING POINTS	00065 STREAM STAGE FEET	82079 TURBIDTY LAB NTU	00530 RESIDUE TOT NFLT MG/L	00535 RESIDUE VOL NFLT MG/L	71821 SPECIFIC GRAVITY SEDGM/GM	71890 MERCURY HG,DISS UG/L	71900 MERCURY HG,TOTAL UG/L
85/04/05	2232	WATER		12145	3A	1		75.0	120	19			
85/04/05	2243	WATER		12168	4A							.2U	.6
85/04/06	0010	WATER		12146	12A	1		135.0	270	32			
85/04/06	0015	WATER		12119	8D	5	1.69		180				
85/04/06	0022	WATER		12169	13A							.2U	.2
85/04/06	0100	WATER		12147	16A	1		195.0	250	31			
85/04/06	0110	WATER		12120	9D	5	1.64		160				
85/04/06	0200	WATER		12148	21A	1		900.0	1000	100			
85/04/06	0210	WATER		12121	10D	5	1.52		1000				
85/04/06	0211	WATER		12170	22A							.2U	1.6
85/04/06	0305	WATER		12149	27A	1		450.0	430	50			
85/04/06	0310	WATER		12122	11D	5	1.43		320				
85/04/06	0401	WATER		12150	32A	1		280.0	260	35			
85/04/06	0410	WATER		12123	12D	5	1.38		160				
85/04/06	0015												
CP(B)-G		WATER			0K15D	5			433		2.59		
85/04/06	0410												
85/04/06	0413	WATER		12171	33A							.2U	.4
85/04/06	0842	WATER		12151	53A	1		80.0	64	12			

476515
35 56 49.4 084 22 01.2 1
UPSTREAM FROM THE INFLUENCE OF EFPC BACKWATER
47145 TENNESSEE ROANE
CLINCH RIVER BASIN 040102
BEAR CREEK 0.55
132TVAC 840601
0000 FEET DEPTH
DATA LOCKED AFTER 84/05.

/TYPA/AMBNT/STREAM

INDEX 1021500 007720 00920 7930 0610 0080 0020
MILES 0953.80 0046.50 567.70 012.00 005.47 001.47 00.55

DATE FROM TO	TIME OF DAY	MEDIA CODE	SMK OR DEPTH (FEET)	80325 SUS PART > 63U MG/L	80322 SUS PART >125U MG/L	80328 SUS PART GT500UM MG/L	80326 SUS PART >2000 UM MG/L
85/04/06	0015						
CP(B)-G		WATER		5.9	2.2	.2	.1K
85/04/06	0410						

APPENDIX III

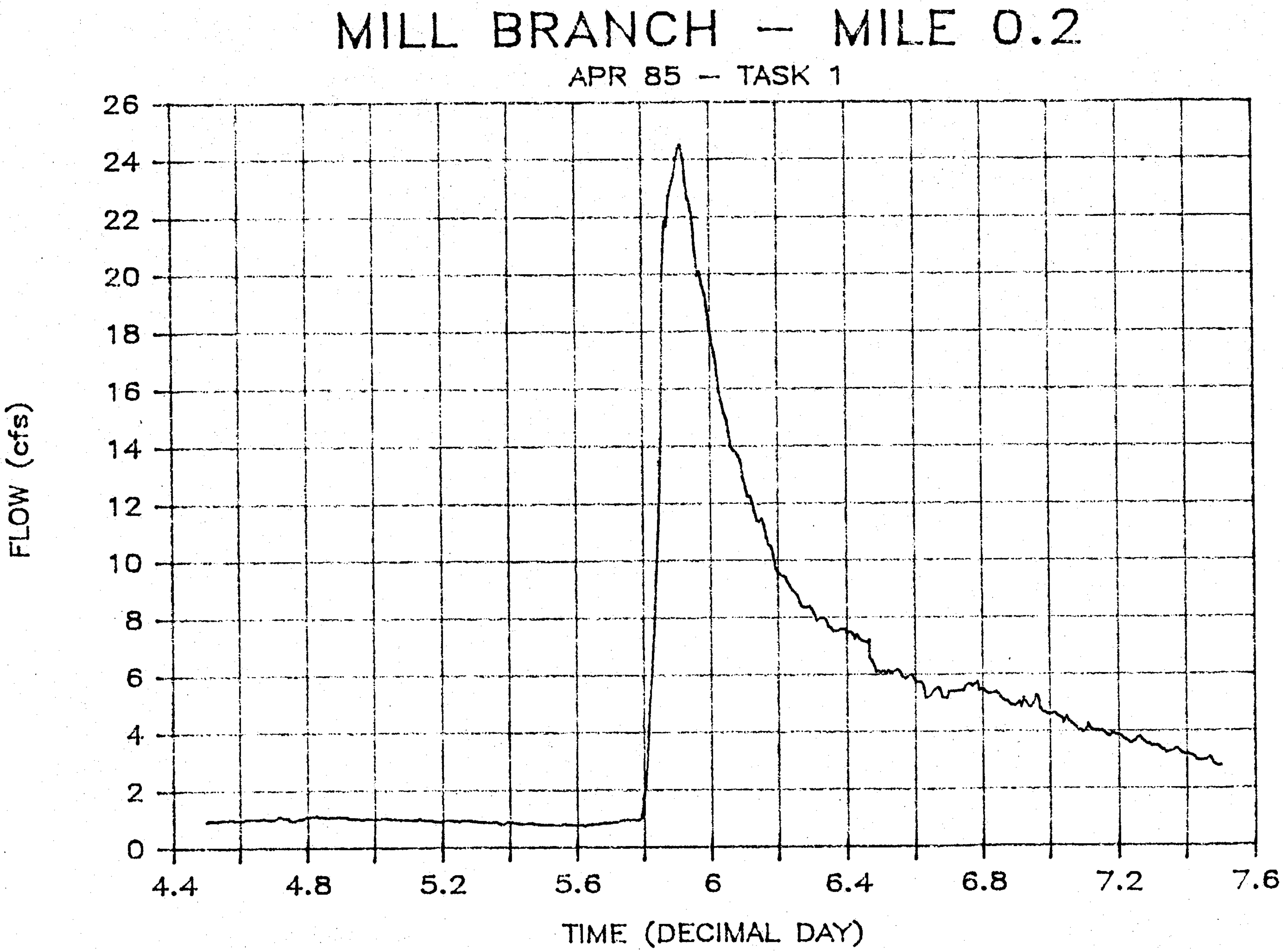

Figure A2: Storm No. 3 Hydrograph - Mill Branch Mile 0.2

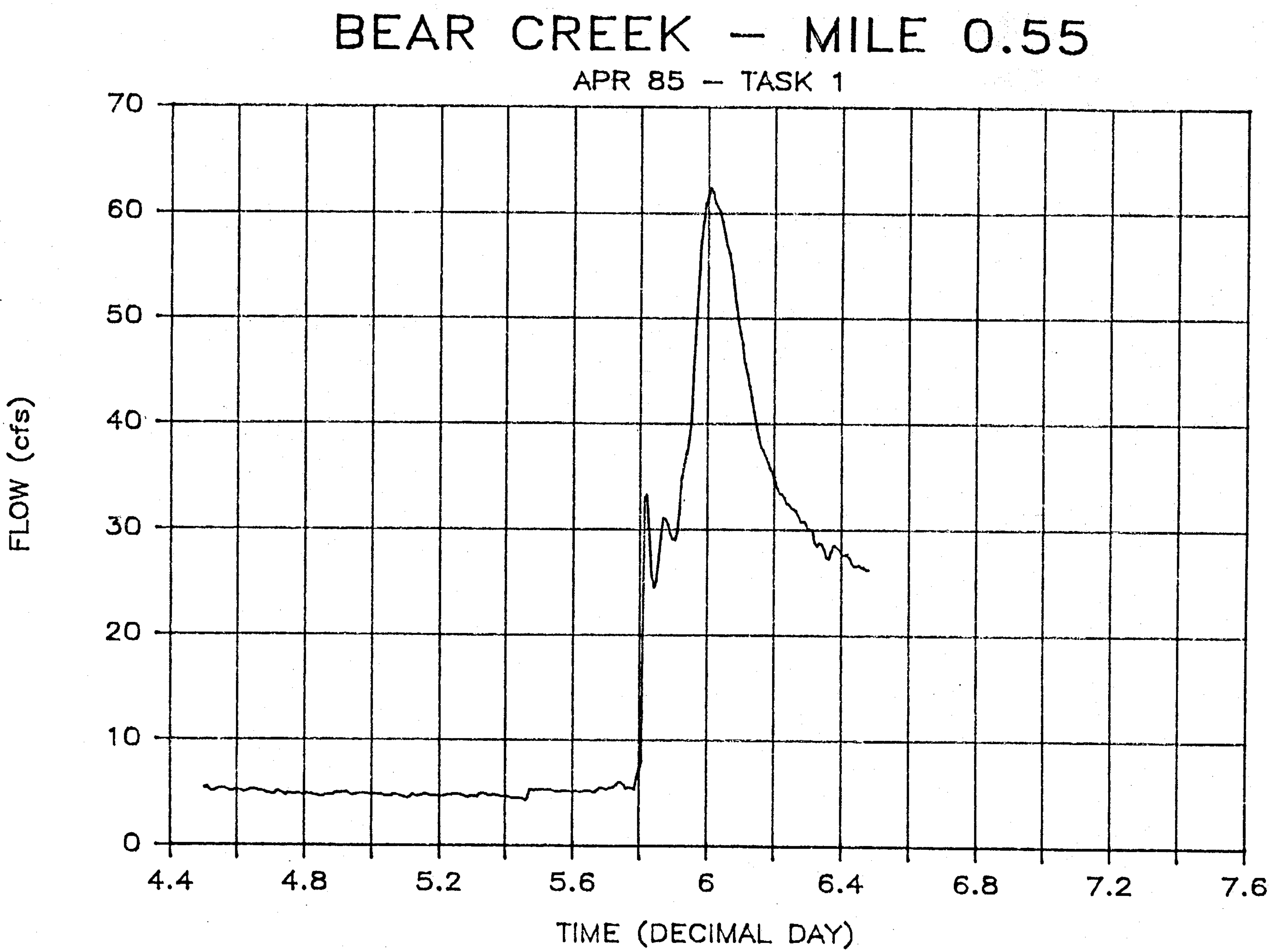

Figure A3: Storm No. 3 Hydrograph - Bear Creek Mile 0.55

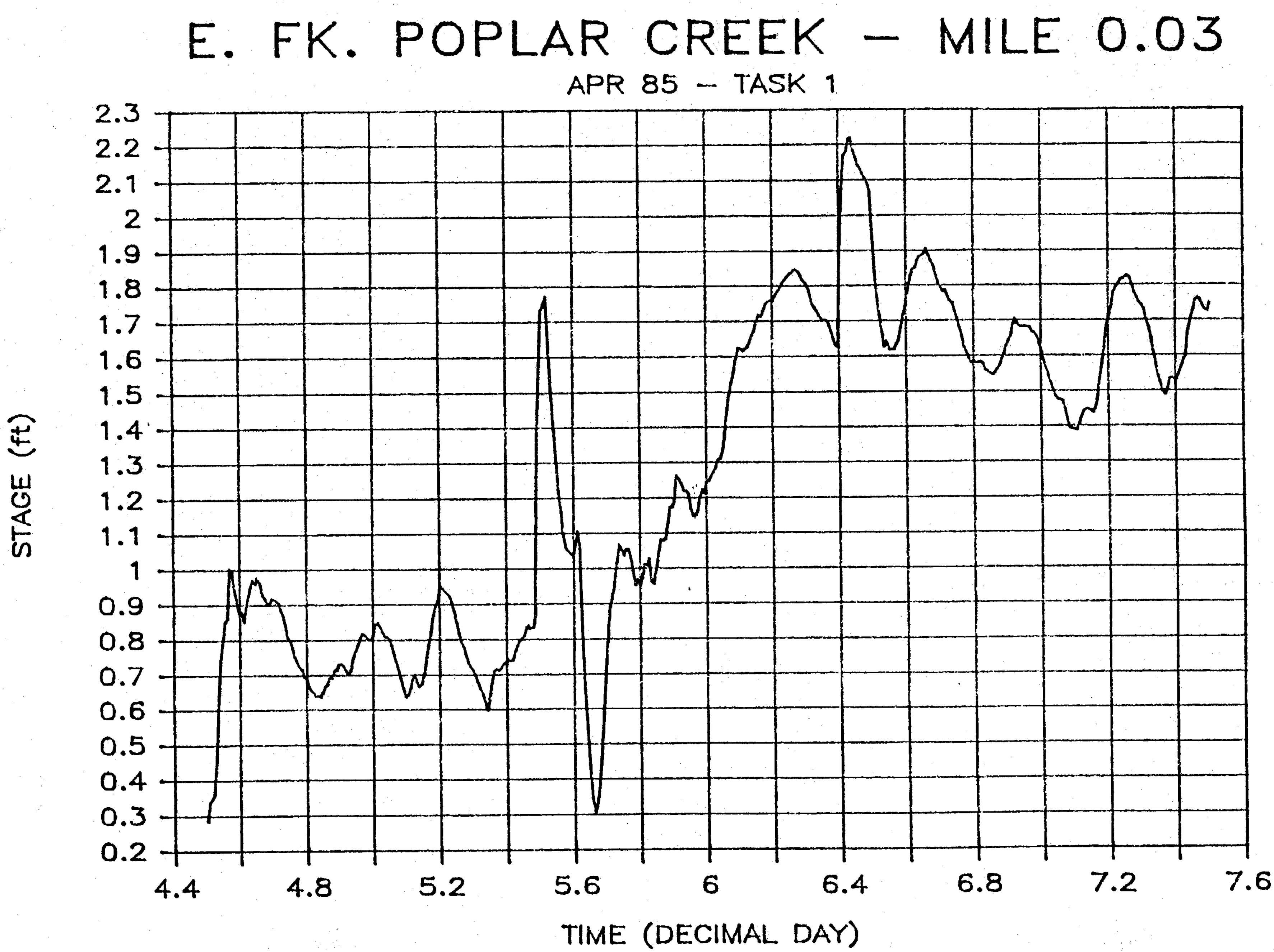

Figure A4: Storm No. 3 Hydrograph - EFPCM 0.03

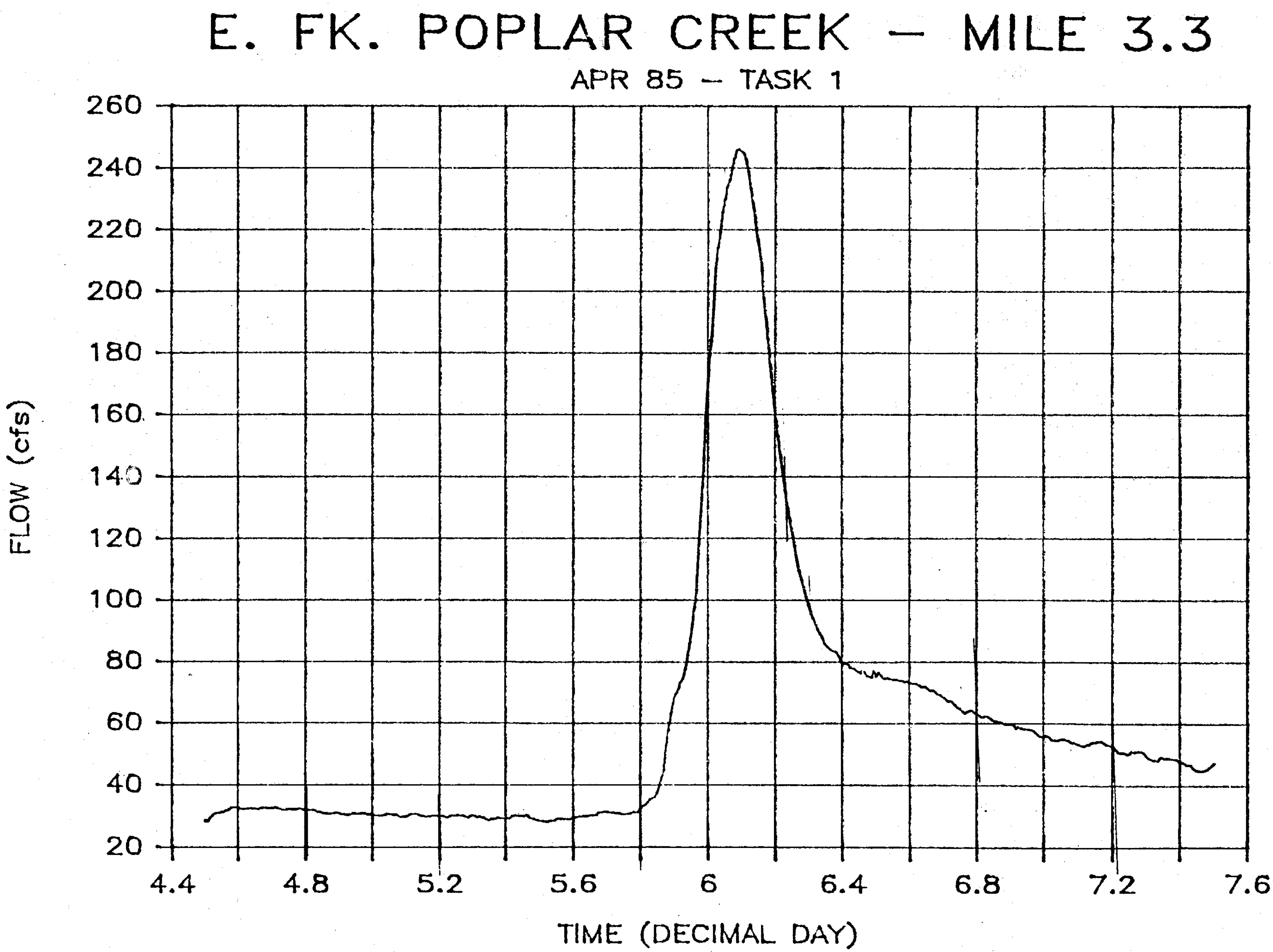

Figure A5: Storm No. 3 Hydrograph - EFPCM 3.3

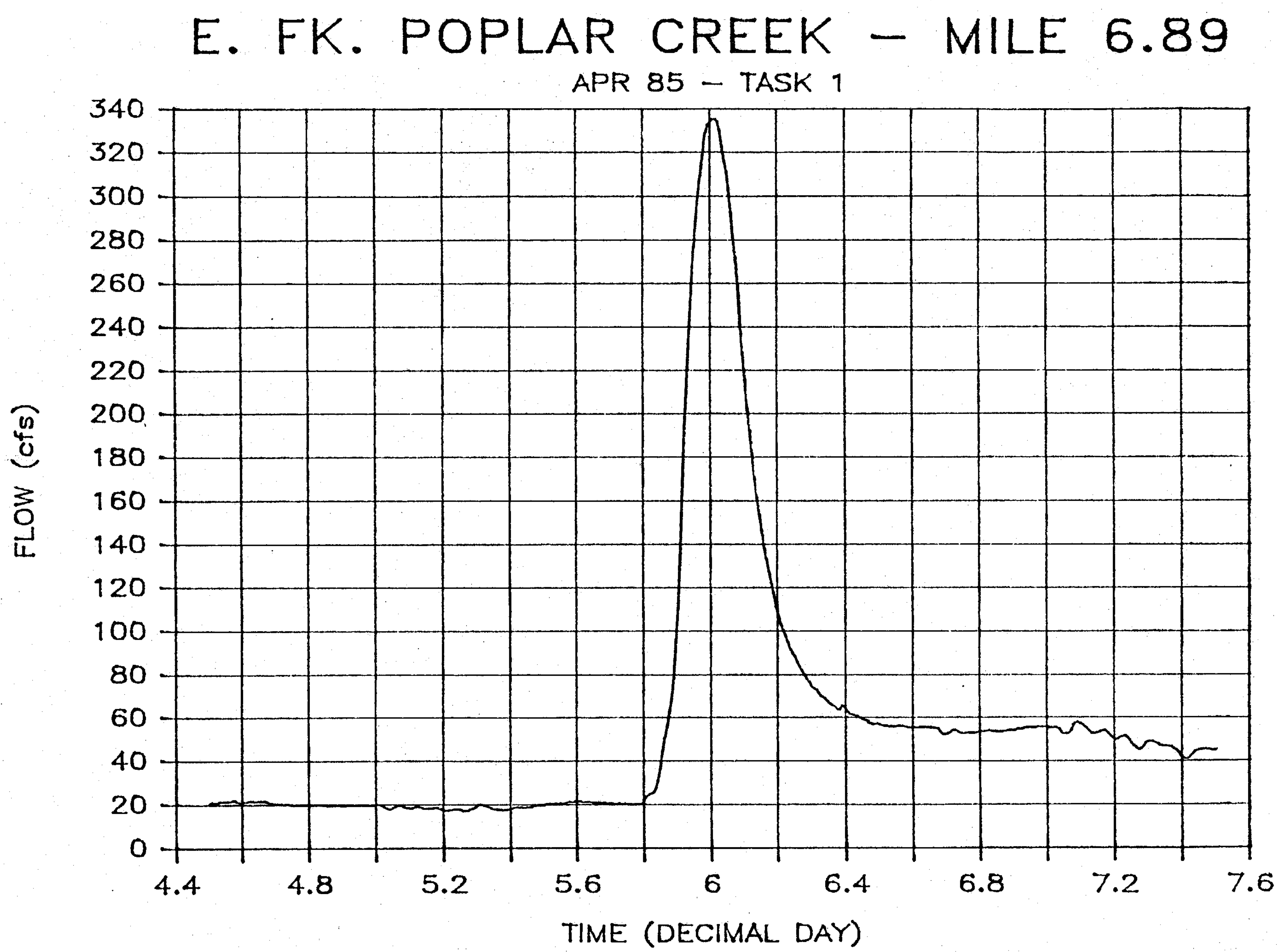

Figure A6: Storm No. 3 Hydrograph - EFPCM 6.89

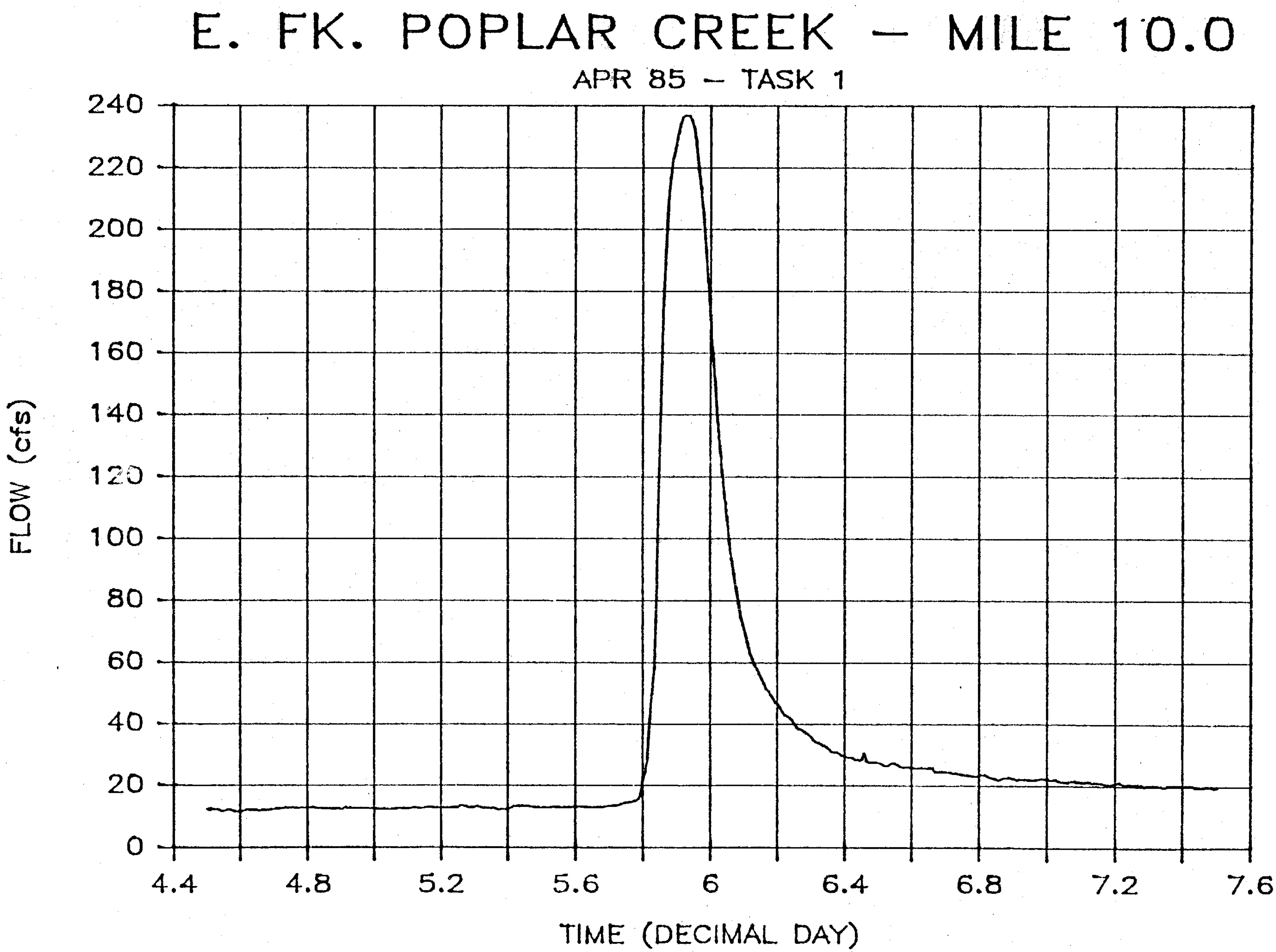

Figure A7: Storm No. 3 Hydrograph - EFPCM 10.0

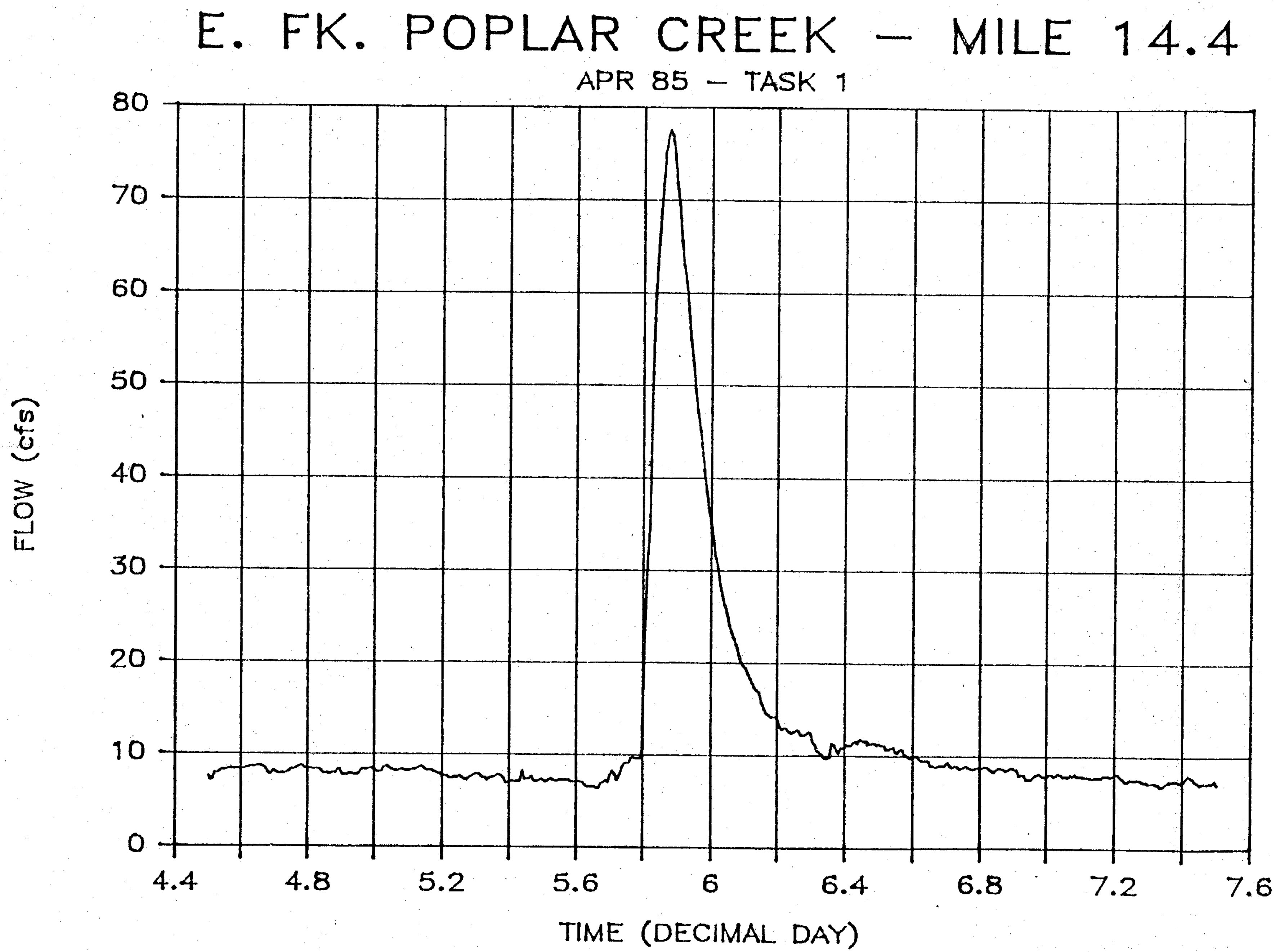

Figure A8: Storm No. 3 Hydrograph - EFPCM 14.4

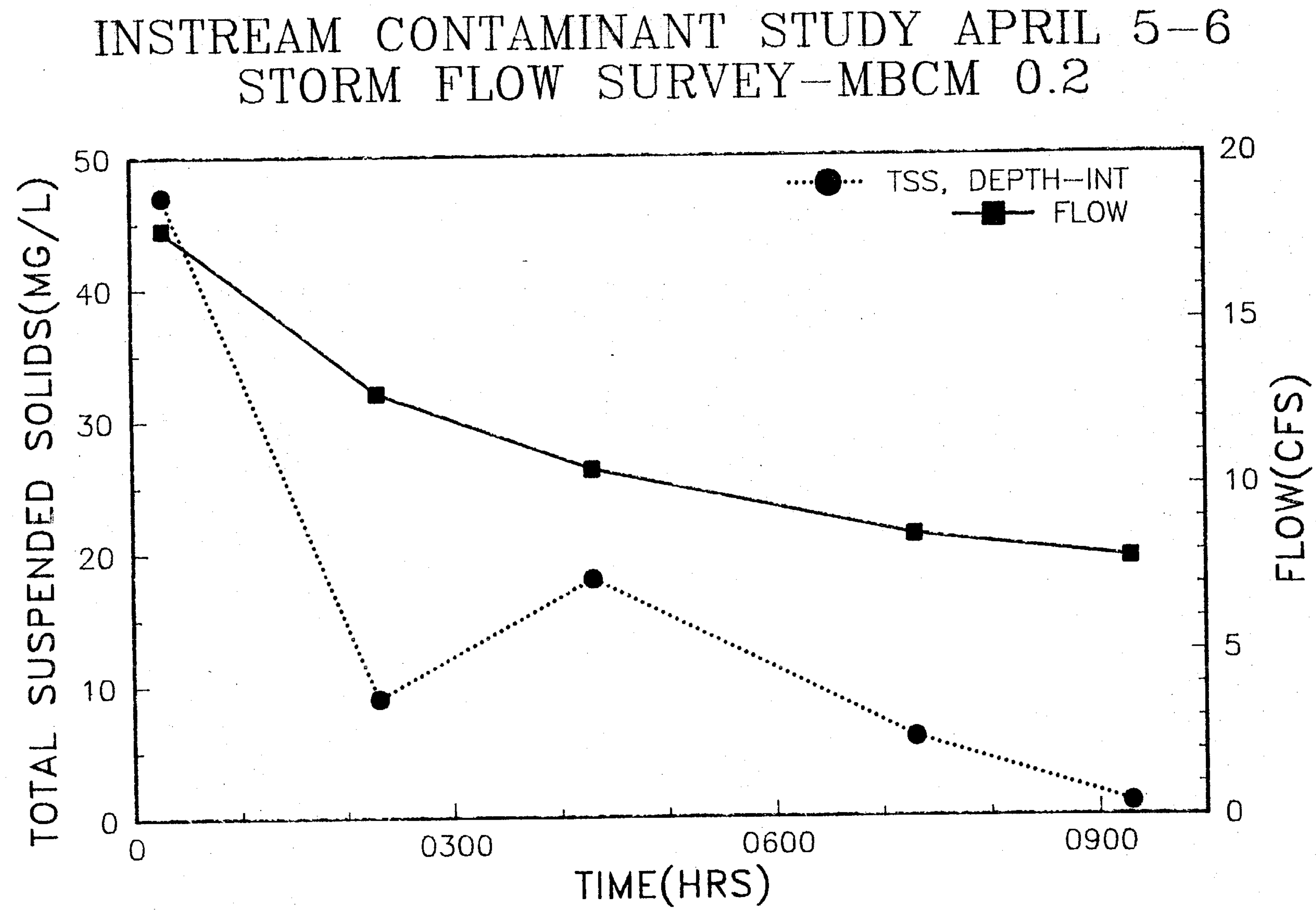

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Figure A9: Total Suspended Solids and Streamflow Storm No. 3 - Mill Branch Mile 0.2

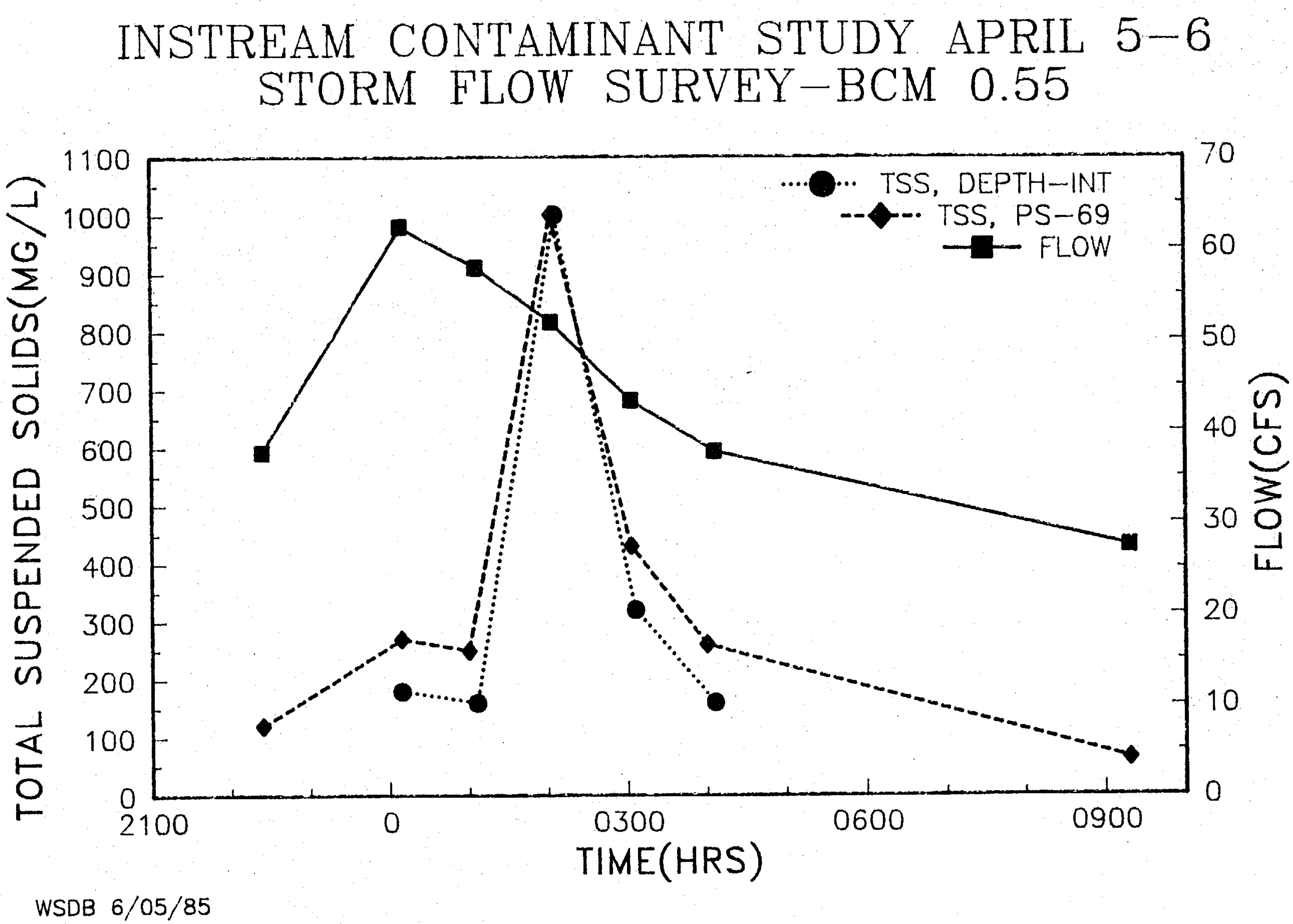

Figure A10: Total Suspended Solids and Streamflow Storm No. 3 - Bear Creek Mile 0.55

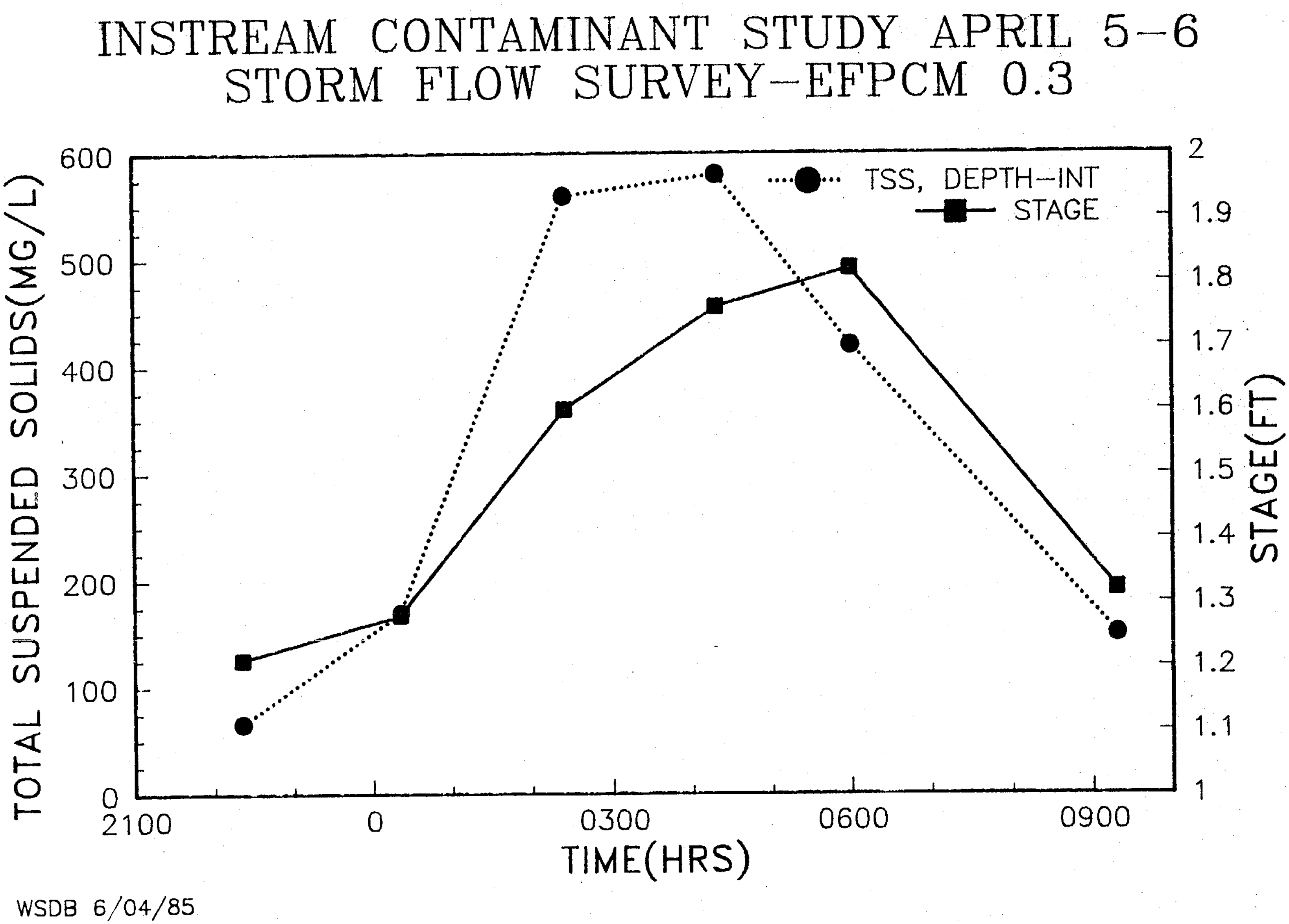

Figure A11: Total Suspended Solids and Streamflow Storm No. 3 - EFPCM 0.03

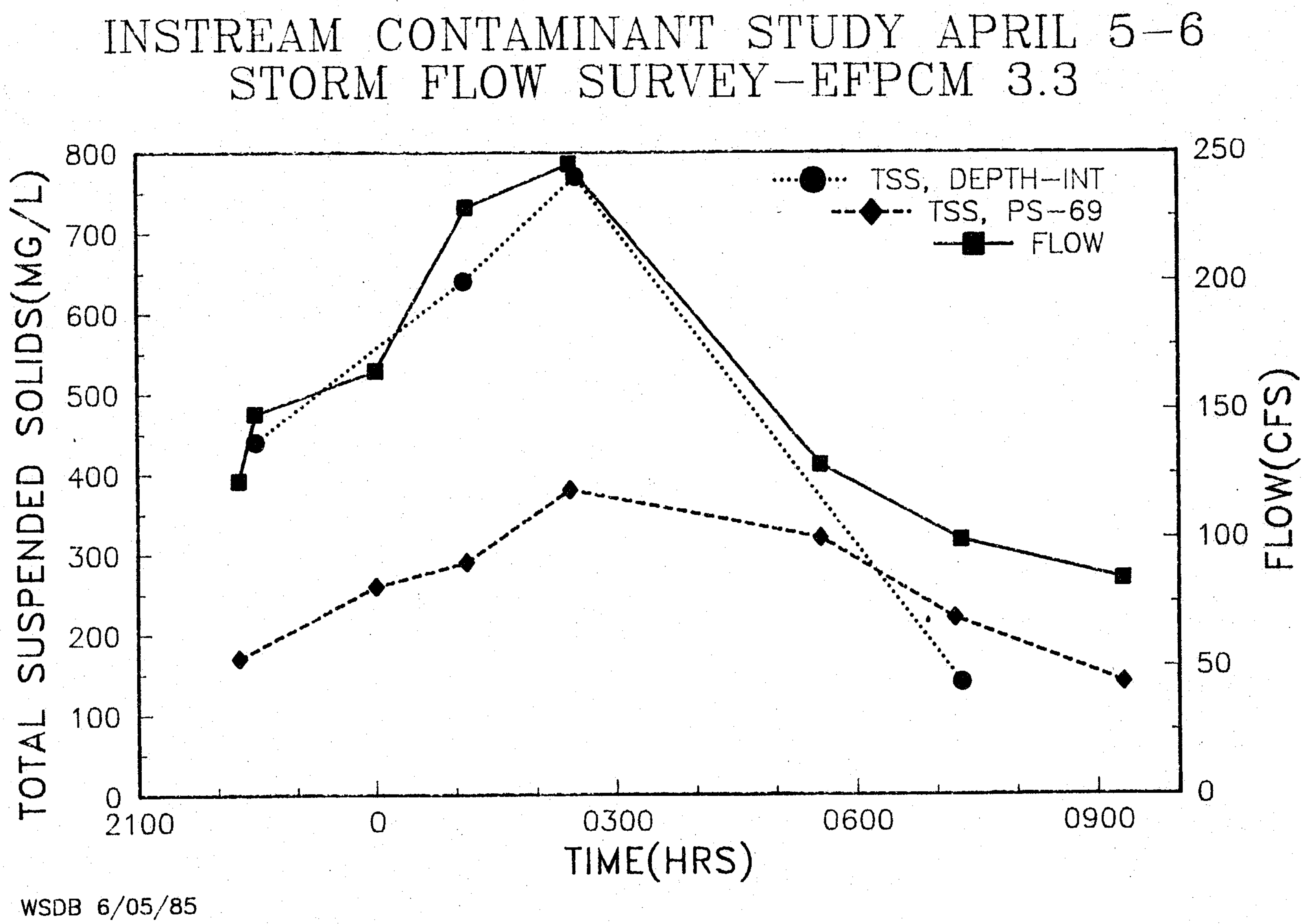

Figure 12: Total Suspended Solids and Streamflow Storm No. 3 - EFPCM 3.3

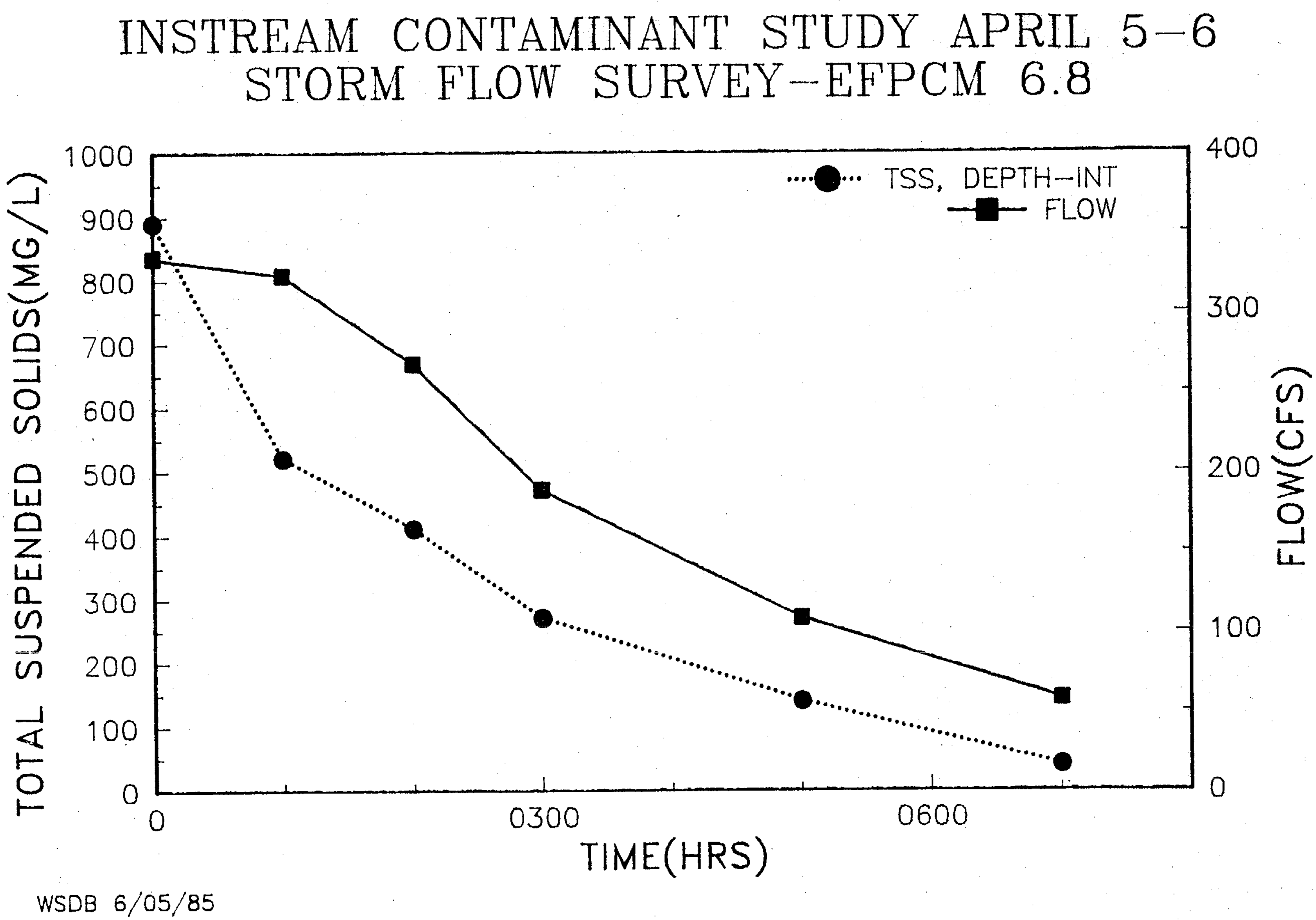

Figure A13: Total Suspended Solids and Streamflow Storm No. 3 - EFPCM 6.89

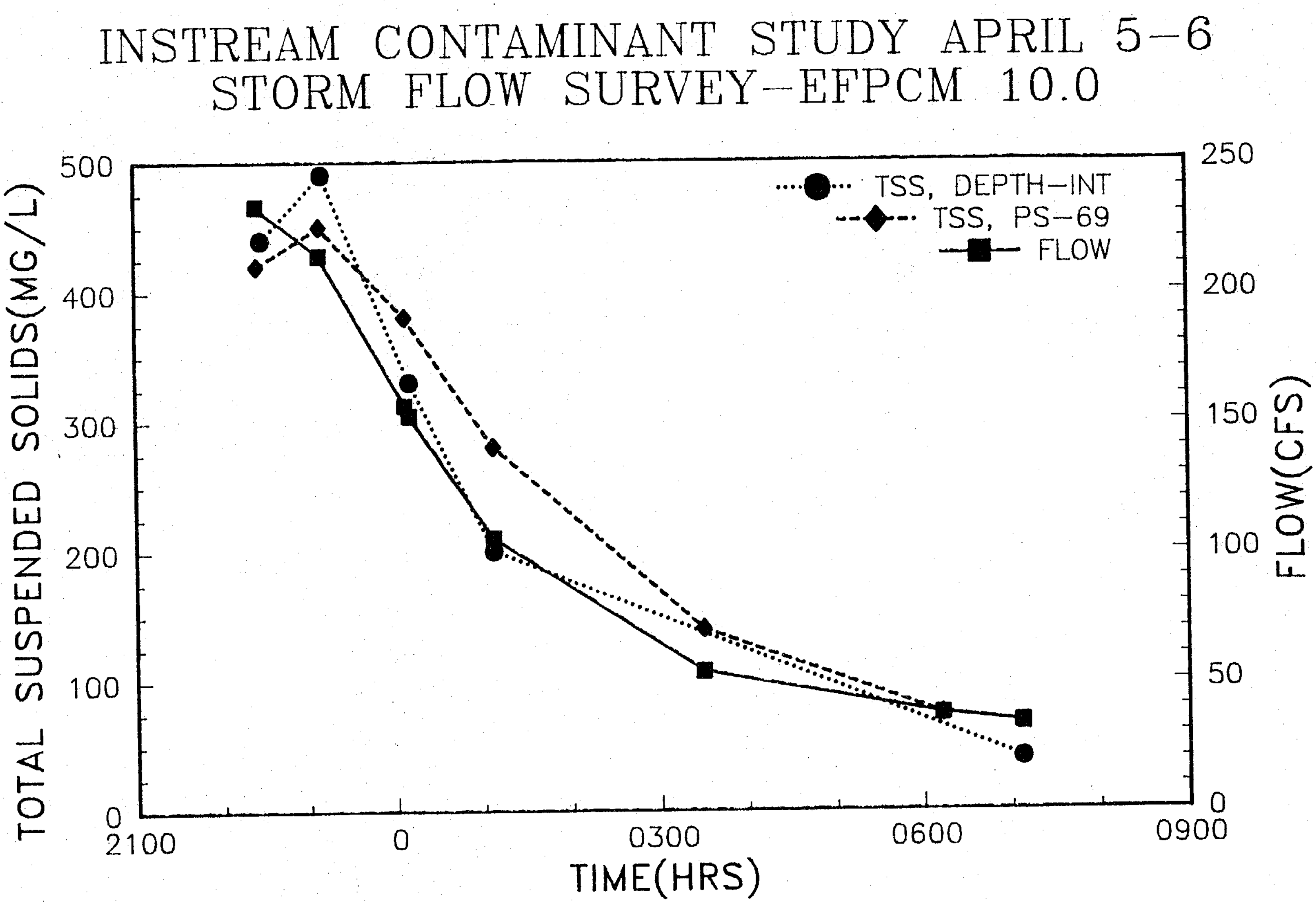

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Figure A14: Total Suspended Solids and Streamflow Storm No. 3 - EFPCM 10.0

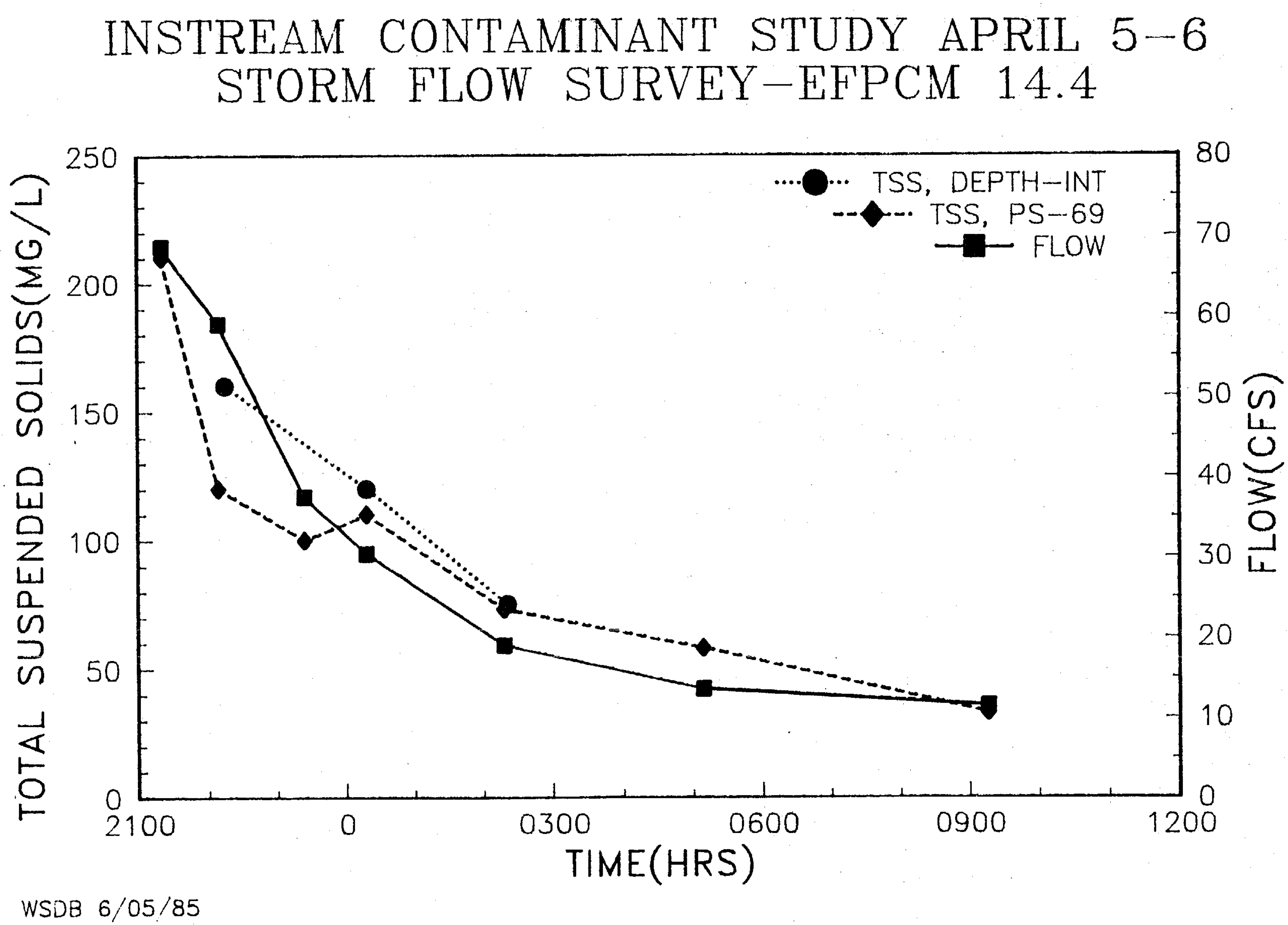

Figure A15: Total Suspended Solids and Streamflow Storm No. 3 - EFPCM 14.4

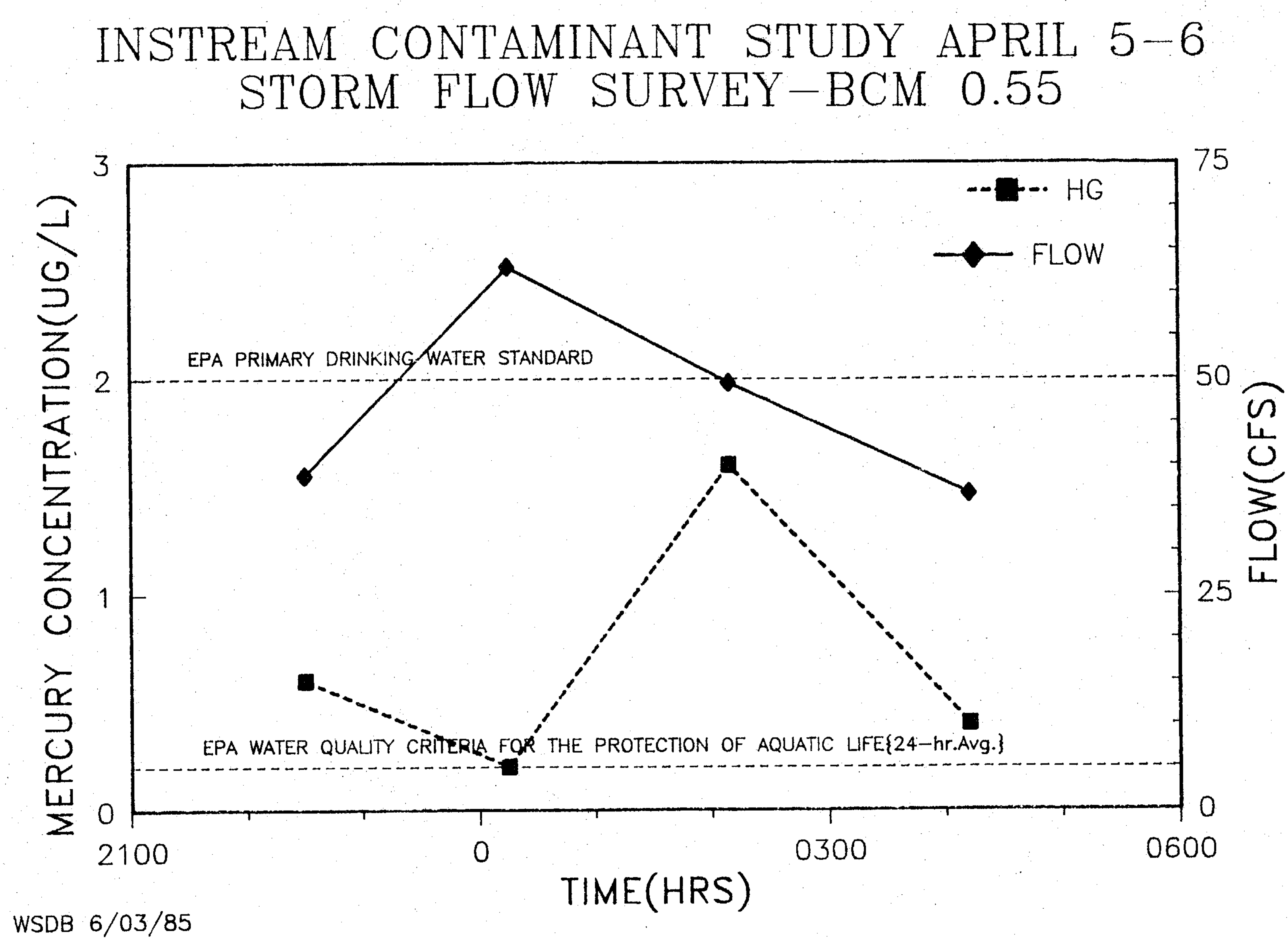

Figure A16: Mercury and Streamflow vs Time Storm No. 3 - Bear Creek Mile 0.55

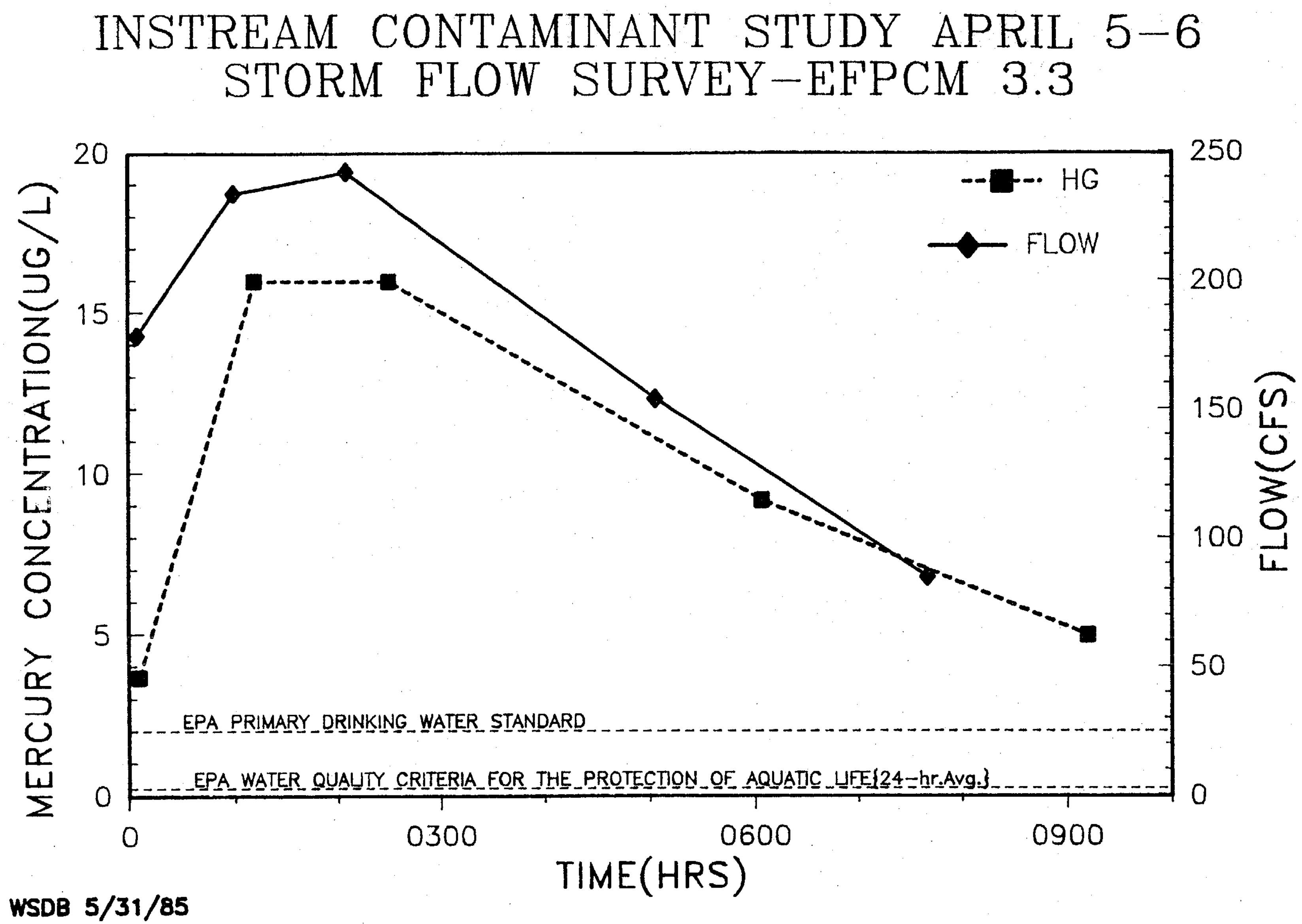

Figure A17: Mercury and Streamflow vs Time Storm No. 3 - EFPCM 3.3

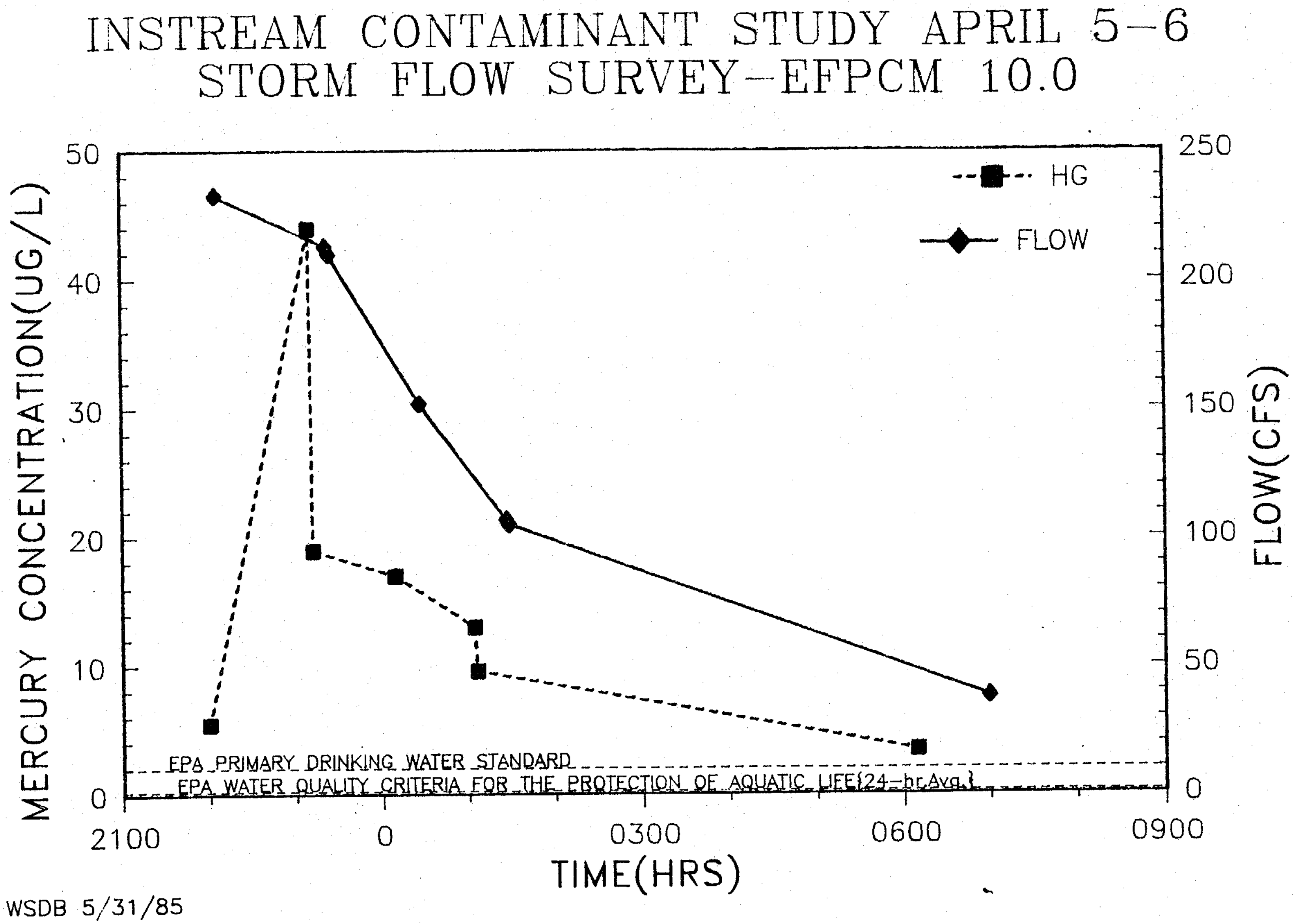

Figure A18: Mercury and Streamflow vs Time Storm No. 3 - EFPCM 10.0

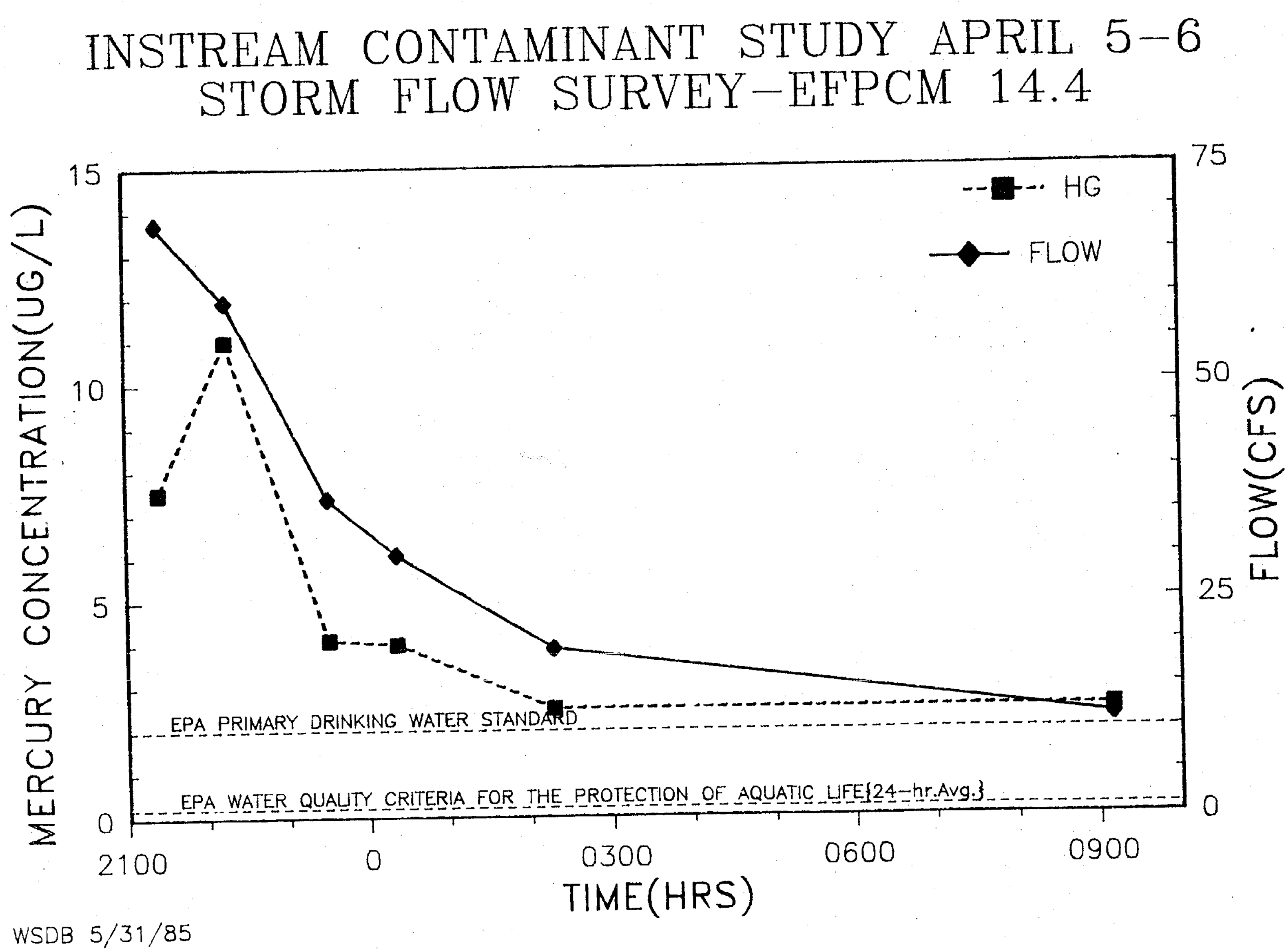

Figure A19: Mercury and Streamflow vs Time Storm No. 3 - EFPCM 14.4